MECHANICAL ENGINEERING

· AUGUST 1949 ·

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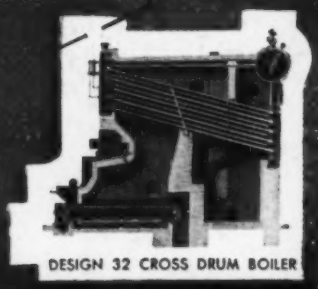
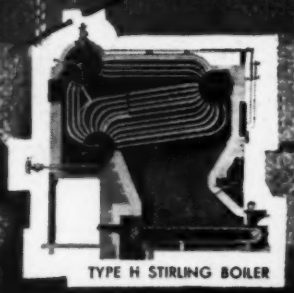
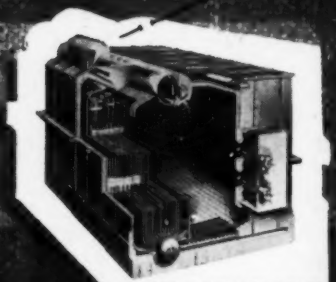


DESIGN 32 CROSS DRUM BOILER



TYPE H STIRLING BOILER



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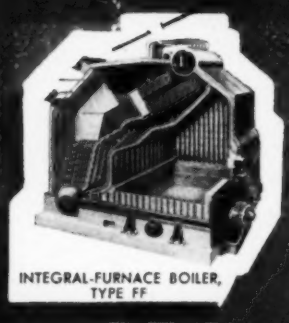

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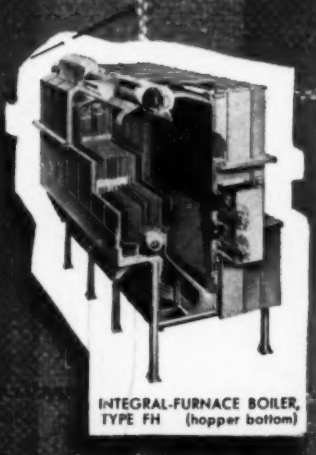

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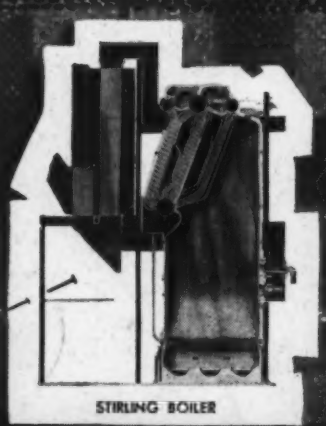
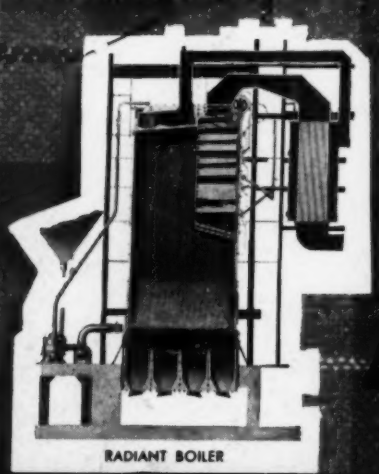
TYPE FH (hopper bottom)



STIRLING BOILER



RADIANT BOILER

BABCOCK & WILCOX

MECHANICAL ENGINEERING

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VOLUME 71 NUMBER 8

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High-Voltage Engineering Research Laboratory

(Vaporization by an artificial lightning discharge of a 15-mil wire strung between the top of an impulse generator and the ground, is shown in the General Electric Company's new High Voltage Engineering Laboratory which recently opened in Pittsfield, Mass. For further details see page 676 of this issue.)

VOLUME 71
No. 8

MECHANICAL ENGINEERING

AUGUST
1949

GEORGE A. STETSON, *Editor*

Engineering in 1880

THE Industrial Revolution, about a century old when The American Society of Mechanical Engineers was organized in 1880, had set up an economy which was under rapid development in the United States. The boundaries of the nation had been pushed westward to the Pacific Coast. The great era of railway construction was affording access to areas where white settlers were establishing farms, mining camps, villages, and cities, all of which called for manufactured goods. The Nation was recovering from the devastation of a war between the states. Wherever a natural water power existed, industrial communities were in active development. The steam engine was approaching its zenith; the great electric power industry had not yet been born, except for isolated cases of arc lighting. Transportation was by rail or water and by horse-drawn vehicles. The cottage system of manufacture was giving place to the factory system. Interchangeable-parts manufacture, which depended upon jigs and fixtures and gages and power-driven machinery, was being practiced; but mass production, which demands mass markets, intense division of labor, and assembly-line techniques, was barely more than a vision. The inventive genius of the young Republic, which had been called into action by casting off economic dependence on Great Britain and had been stimulated by such forward-looking groups as The Franklin Institute, was finding unlimited opportunity for development. The great Centennial Exposition at Philadelphia had opened the eyes and stimulated the imagination and ambition of hundreds of young and active minds and had given a tremendous fillip to the growth of industry. The skill of the craftsman was at its height and the spirit of enterprise, nurtured by democratic ideals, growing markets, and almost limitless opportunities for the inventor and the manufacturer, afforded an atmosphere in which men of humble birth could look forward with reasonable confidence to becoming captains of industry and citizens of wealth and influence. The mechanic arts were assuming the stature of an engineering profession.

What manner of men were those who were calling themselves mechanical engineers? They were educators, like Robert Henry Thurston; consulting engineers, like Alexander Lyman Holley; manufacturers like Henry Robinson Towne and Henry Rossiter Worthington; designers like Erasmus Darwin Leavitt and Edwin Reynolds; editors like Jackson Bailey and William Kent; publishers like William H. Wiley; and dozens of inventors, high-grade mechanics, and operating engineers. In those early days formal college education was not as common a gateway to engineering as it is today—indeed, the number of colleges was small, and the shop and the drafting room were the basis of technical training.

These men had few technical magazines to keep them abreast of engineering progress. Textbooks and other scientific and technological works were limited in number, and many were published abroad. The public library was a rarity and paid little attention to engineering books. The card catalog was unknown. What few handbooks there were treated civil-engineering subjects. Codes and standards were practically unknown. Science and technology were miles apart. Research in engineering and technology was not dignified by so high-sounding a title. Indexes and abstract services were not available.

It is not strange that under such conditions as have been hinted at in the foregoing paragraphs, one of the first projects of the young American Society of Mechanical Engineers was to set up a Committee on Publications and to issue for the benefit of its members an annual volume of Transactions. Nor was it strange that men who had so little engineering and technical literature at their command should find in the Transactions a wealth of information useful to them in their daily work. ASME Transactions met an urgent need by providing members with published material they could obtain in no other way than by becoming members of the Society. A major part of the energies and resources of the Society were devoted to the publication of engineering papers and to the meetings at which those papers were presented and discussed.

Engineering in 1949

HOW different conditions are today. The economy of the western nations has become predominantly industrial and is based on science and engineering. Whatever sector of life we examine, science and the machine have combined to lighten human labor and increase the productivity of nature and of man. Mass markets have made mass production a reality. Research has become a prerequisite to survival. In engineering a college education is practically essential to success. Skills have been transferred to mechanisms. In most industrial enterprises the human element is largely concentrated in the functions of control of machines and processes, and to make this possible thousands of types of instruments and devices and management of men em-

ployed in those enterprises have become one of the more important tasks of engineers. Science has entered the workshop, and concentrations of scientists in industry are becoming larger than those in universities. The empirical approach which was born of necessity in the manufacturing plant has given place to the scientific method and to the analytical skill of the mathematician, the physicist, the chemist, and a host of fellow scientists. The important frontiers are no longer those of geographical exploration and pioneering but are in the mind of man and the undiscovered fields of Nature herself.

As contrasted with conditions that existed seventy years ago, those which we find today are rich in aids to the engineer. Well-stocked, well-catalogued libraries —public, institutional, industrial—are numerous, well-distributed, and readily accessible. They have competent and trained staffs. Technical publications of all types are being produced at a rate which affords an embarrassment of riches. Were he ever so wealthy and able to purchase all the technical material published in his field, an engineer of today would not have time to read it all. To aid him in the task of keeping abreast of the ever-growing mass of literature pertaining to his field of specialization, the modern engineer has index and abstract services and bibliographies sponsored by hundreds of organizations. Far from suffering an intellectual hunger and thirst, he faces the problem of selecting such morsels from the abundant larder of human knowledge as will give him the needed nourishment without mental indigestion and the torpidity of overindulgence.

Nor does this exhaust the acute and confusing contrasts of 1880 and 1949. Examination of the list of professional divisions and technical committees of ASME will reveal that they relate to subjects unknown or only primitively developed when the Society was founded. Applied mechanics, heat transfer, steam power, fuels and combustion, lubrication, design, production, and materials were subjects of major importance to mechanical engineers in those early days, but they were more closely related to the mechanic arts than to the sciences upon which they are based. Electrical machinery and devices had little to offer the mechanical engineer. Metallurgy was of the crudest sort. The great variety of industrial metals was just beginning to develop. Synthetic materials had to await the coming of the chemical engineer. Fluid flow was confined principally to water. The internal-combustion engine, the steam turbine, and the gas turbine had not been built commercially. Aeronautics was a fantastic dream. Petroleum meant oil lamps. Instruments were few and crude, and instrumentation a limited and undeveloped field. The relation between engineering and the biological sciences was practically unknown. Education was of primary concern, but the American Society for Engineering Education had yet to come into existence and breathe into it the spirit of self-analysis and self-improvement. Professional consciousness was awakening, but scarcely a subject of broad concern to engineering students, practitioners, and the public. Codes and standards were in their infancy. Research was something carried on in the European universities by scientists and professors. The atom was of academic interest only, and nucleonics an unknown word. Taylor was yet to write on metal cutting and scientific management, the Gilbreths on motion study, Gantt on the production-control charts, and Clark on the removal of obstacles to a free flow of work. There were no local sections, no student branches, no superorganizations like the Engineers' Council for Professional Development and the Engineers Joint Council. The United States was provincial and isolationist and looked to Europe for scientific, cultural, financial, and commercial leadership. Labor was a personal relationship between employer and employee and scarcely a subject for engineering discussions.

ASME Publication Changes

HISTORICALLY, the formal publications of engineering societies have taken the form of Transactions, Proceedings, or journals, issued periodically every year or more frequently, and composed largely of original technical papers by individual authors and selected by a committee on the basis of their significance and value as additions to the literature of the field in which the Society operates. For financial reasons and for convenience, publications of this type originally contained also committee reports, historical records, résumés of meetings, biographies of deceased members, important documents like the Charter, Constitution and By-Laws, membership lists, and miscellaneous information of current and permanent value. With the passage of time and the institution of other means of publication, the Transactions-type of publication gradually has been losing everything except the technical papers, with discussion, and a few important technical reports. Until recently it has been customary to send a copy of Transactions publications free of charge to every member. Only in 1948 did ASME, for example, place its Transactions on a subscription basis. Faced with sharply rising costs, a great diversity of interest in subject matter among its members, a growing number of members in retirement or occupying administrative posts where technical literature is seldom read, and after providing other means by which a Transactions type of paper could be obtained by a member specifically interested in its subject matter, did ASME take this step.

Transactions has become an archive, reference type of publication, destined largely for libraries and as source and reference material for use by a limited number of consultants, teachers, designers, and research workers for whom a personal copy is a necessary convenience because of the broad range of their technical interests.

With this change in the concept of Transactions it is apparent that in such a publication there should appear only papers of highest technical value and quality, original contributions of "permanent" interest, notable additions to mechanical-engineering knowledge.

[Based on an address delivered at the Fifty Seventh Annual Meeting, Rensselaer Polytechnic Institute, Troy, N. Y., June 20–24, 1949.]

RETORTING METHOD *for* RECOVERY *of* SHALE OIL

Details of Equipment Developed by the Union Oil Company

By HOMER REED and CLYDE BERG

UNION OIL COMPANY OF CALIFORNIA, LOS ANGELES, CALIF.

THE shale-oil reserves of the United States are conservatively estimated to constitute over 100 billion barrels, of which almost 50 billion are recoverable in Colorado alone.[1]

With the idea of advancing the time when this tremendous energy potential can be utilized, the Union Oil Company is carrying on an extensive program to develop processes for retorting shale and refining the extracted oil.

As the first step in this program, Union has developed a continuous retort which because of its unique counterflow principle, eliminates the need for large quantities of cooling water and heat exchangers, thereby greatly reducing operating and capital costs. The development studies of this retort have progressed from a 2-ton per day pilot unit to a 50-ton per day semicommercial unit. It is expected that commercial units will reach the capacity of 4000 tons per day of oil shale.

Oil recoveries in the Union shale-retorting-kiln operation consistently exceed the assay value for the oil content of the shale. Considerable quantities of fuel gas are produced which will provide a large resource of potential power at the retorting and mining site.

HISTORY

The production of oil from shale antedates the production of oil from wells by about 20 years. When the latter production was developed, there were about fifty plants in the United States producing oil from shale, and many similar plants in Europe, notably in Scotland and France. This industry was unable to compete with the oil from wells. Those few plants which survived before 1940, were located in Scotland, Estonia, and Manchuria.

The shale kilns employed in the Scottish retorting operations are essentially externally fired vertical kilns and have been described widely in the literature. Manchurian shale kilns are a modification of gas-producer construction wherein the actual retorting is effected by the circulation of a mixture of producer gas and shale off-gas. Estonian shale retorting features the so-called Kivioli tunnel oven wherein shale is retorted while carried in steel cars through a high-temperature tunnel. During the second world war a variety of shale retorts were developed in Germany and France. Exploitation of this source of synthetic fuel was particularly intensive in Germany during the latter stages of the war.

In the United States some recent thought and development effort have been given to the application of thermofor catalytic-cracking (TCC) and fluid-cracking techniques to the retorting of shale.

[1] "Studies of Certain Properties of Oil Shale and Shale Oil," by Boyd Guthrie, U. S. Bureau of Mines Bulletin 415, 1938, 159 pp.

Contributed by the Petroleum Division and presented at the Petroleum Mechanical Engineering Conference, Amarillo, Tex., October 3–6, 1948, of The American Society of Mechanical Engineers.

GENERAL CONSIDERATIONS LEADING TO DEVELOPMENT OF UNION OIL RETORT

The development of the Union Oil Company retort was carried out in conjunction with economic studies of a variety of existing shale-retorting methods. Generally speaking, the existing methods of shale retorting resulted in operating costs which eliminated the possibility of their being employed when viewed from the standpoint of producing oil competitive with existing crude-oil prices. The factor which caused most previous shale-retorting methods to fail from this economic aspect was that of capital investment. Large quantities of shale must be processed in the commercial production of shale oil, and the quantities of heat which must be exchanged are consequently large. Facilities to effect transfer of the quantities of heat involved through exchanger surfaces or by means of recirculating gas streams involve large investments. These investments were found to range as high as $1500 to $3000 per barrel. Associated with this high-investment aspect, most shale-retorting processes incur a large utility requirement, necessitating tremendous quantities of cooling water, and frequently utilize all of the gas production from retorting to supply fuel for operation.

The Union Oil retorting process, because of its simplicity, will be relatively low in capital cost, and furthermore the utility requirements are virtually eliminated, no cooling water or supplementary fuel being required in the retorting operation.

DETAILS OF UNION OIL RETORT

The retort for this process employs an underfeed principle with countercurrent flow of shale and air. The ash and clinkers are removed overhead and the oil drains out the bottom of the unit. The oil is distilled by downward flow of heat furnished by the combustion of the residual carbon on the shale clinker at the top of the kiln. The heat available for other purposes from the combustion of the stack gases is equivalent to 25 to 35 per cent of the fuel value of the shale oil. Very efficient heat exchange is obtained in the unit by direct contact. The incoming air is preheated by the spent clinker and the products of distillation are condensed on the cool incoming shale. The shale clinker is discharged hot because of the excess of heat available from combustion of residual carbon on the clinker.

The 2-ton per day pilot plant, shown in Figs. 1 and 2, consists of a cylindrical kiln with an underfeed mechanism, permitting the movement of granular shale upward through the unit with an overflow at the top where the clinker is removed by a scraping mechanism and falls into an ash-disposal chute. The sections of the kiln expand gradually upward, minimizing restriction to upward movement. The retorting section in this unit is 30 in. high and 12 in. in diam at the bottom. A conical slotted section below the retorting section effects the separation

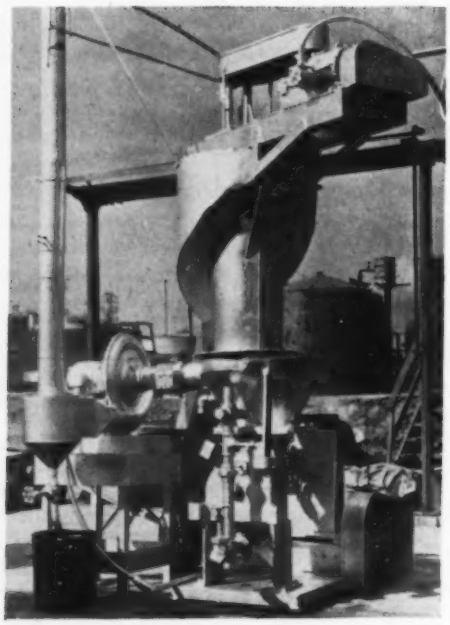

FIG. 1 TWO-TON PER DAY SHALE UNIT

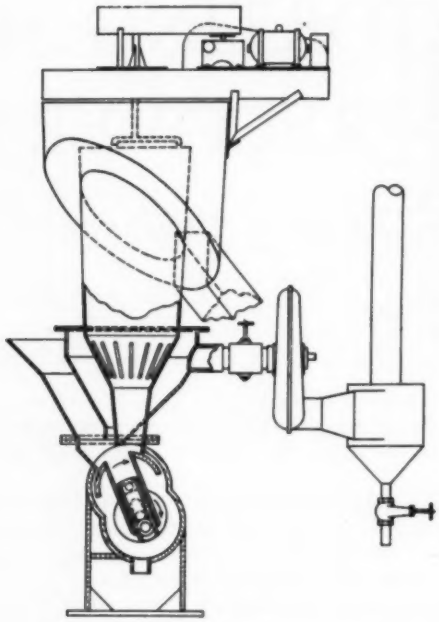

FIG. 2 DIAGRAM OF SHALE KILN

of the oil and gas from the incoming shale. A collector surrounds this section, and the gas is drawn from this through a blower and oil collector. It will be noted that the feeding mechanism is so constructed that any fines which fall through the grate return to the feeding piston and are reintroduced so that the gas and oil-collecting housing cannot suffer from plugging due to accumulation of fines. The feeding mechanism is filled with oil to a level just below that of the slot edges, providing a liquid seal which prevents the blower from pulling in air through the feed hopper. Between the kiln and the blower there is a butterfly valve which controls the air drawn through the kiln. Discharge of the blower passes directly to the oil-collection cyclone, where the liquid product is taken and the fuel gas is produced overhead.

The process occurring in the kiln-retorting section may be divided into three zones. In the top zone, heat exchange between incoming air and hot clinker leaving the unit is effected. In the lower portion of this top zone, combustion of the carbon residue on the clinker is effected, producing flue gas with a temperature approaching 2000 F. This flue gas progresses into the second zone, which may be termed the retorting zone, wherein the oil vapors are educted from the shale. The mixture of shale-oil vapors and the flue gas progresses downward into the third zone, termed the condensation zone, where the incoming green shale is heated and the products of eduction are cooled and the oil condensed. The exit oil and gas from the kiln approach within 20 deg of the shale being charged. A graph of the typical temperature profile in the shale kiln is presented in Fig. 3.

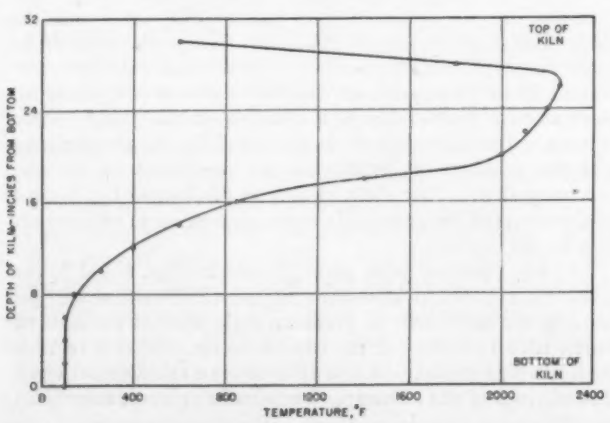

FIG. 3 TYPICAL TEMPERATURE PROFILE 2-TON PER DAY SHALE KILN

OPERATION OF RETORT

To put the kiln in operation it is filled with shale. The crankcase and disengaging section are filled with oil from the previous run. A layer of kindling wood is placed on the top of the shale and ignited. The blower of the kiln is then started, which draws the fire down through the shale bed, igniting the mass of shale. When it is observed that the top layer of shale has burned to a clinker, the feeding mechanism and the ash-removal equipment are started. Oil production is normally obtained from the unit within 10 to 15 min after ignition.

Results of pilot-plant operations are presented in Tables 1 and 2. It will be noted that in a typical operation charging the unit at a rate of 1.84 tons per day, 58 gal shale oil per ton of shale were produced, exceeding somewhat the retort-analysis figure of 57.2 gal per ton. In this operation, 19,100

TABLE 1 TYPICAL PILOT SHALE-KILN OPERATION

Shale:	
Rate, tons per day	1.84
Oil content by Fischer Assay, gal per ton	57.2
Oil:	
Production, bbl per day	2.54
Production, bbl per ton shale	1.38
Recovery, per cent oil by retort	102
Gas:	
Production, M cu ft per day	35.2
Production, M cu ft per ton shale	19.1
Heat content, Btu per cu ft	188

TABLE 2 SURVEY OF SHALE OIL

(Operation on 55-gal per ton shale)

Shale Oil:	
Gravity API at 60 F	21.6
Water by distillation	0.2
Viscosity SU at 100 F, sec	113
Sulphur, per cent	1.26

REFINING CRUDE DISTILLATION

Material	API at 60 F	Dry bases, per cent
Gasoline—410 deg F end point	44.1	11.2
Gas oil—41 Viscosity SU at 100 F, sec	29.2	27.9
Residuum	15.1	60.3
Loss	....	0.6
Total	....	100.0

Gasoline:

Gravity, API at 60 F	44.1
Sulphur, per cent	1.15

Init.	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	Max.	Recovery	ABP[b]
220	301	318	330	340	350	360	370	380	392	401	412	98.5%	341.4

Gas Oil:

Gravity, API at 60 F	29.2
Viscosity SU at 100 F, sec	40.6
Upper pour point, deg F	5.0
Sulphur, per cent	1.14

Init.	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	Max.	Recovery	ABP[b]
435	502	510	526	540	554	570	587	608	630	647	676	98%	558.0

Residuum:

Gravity, API at 60 F	15.1
Viscosity Saybolt Furol at 122 F, sec	95
Flash, COC[a] deg F	445
Sulphur, per cent	1.07

[a] Cleveland open cup.
[b] Average boiling point.

cu ft of 188-Btu-content gas were produced per ton of shale and 0.58 ton of ash were produced per ton of shale. The shale oil produced by the unit had a gravity of 21.6 deg API and a sulphur content of 1.26 per cent. The analysis of the gas produced is given in Table 3.

TABLE 3 ANALYSIS OF GAS FROM SHALE KILN

(Operation on 55-gal per ton shale)

	Mol per cent
Hydrogen	3.9
Nitrogen	57.5
Air	6.0
Carbon monoxide	11.0
Carbon dioxide	13.3
Hydrogen sulphide	0.4
Methane	3.3
Ethane	1.7
Propane	1.6
Butanes	1.0
Pentanes	0.3
Total	100.0
Specific gravity	1.000
Gross heating value, Btu per cu ft	188

An appreciable quantity of nitrogen bases is present in this product. The sulphur distribution is somewhat unusual in that the highest content of sulphur is found in the lighter fractions of the stock.

DESCRIPTION OF 50-TON PER DAY SEMICOMMERCIAL UNIT

The 50-ton-per-day semicommercial shale kiln is shown in Fig. 4, and the assembly detail drawings in Fig. 5. The overall design of this large unit closely parallels that of the smaller unit. However, the feeding mechanism is actuated hydraulically, which provides a maximum of flexibility in control of feeding action and an economical construction for large-size units. The ash-removal mechanism is also driven by a hydraulic mechanism. The large shale kiln employs a finned retorting section with cowling to direct an air flow over the fins. A secondary stack draws the air through this cowling section. Cooling of the shell is designed to effect a maximum metal temperature of 750 F at the burning zone. The gas flow through the kiln proper is provided by means of a Type W Roto-Clone. An ultrasonic mist-agglomeration unit processes the gas leaving the Roto-Clone to recover mist which carries through the preceding oil-collecting unit. The retorting section of this kiln is 7 ft high and 4 ft diam at the lower end and expands to 5 ft diam at the top. The disengaging grate in the unit is similar to that of the smaller plant and has automatic fines removal from the collector section. Operation of the kiln is entirely automatic. Flow of air through the unit is controlled by an automatic flow controller, actuated by an orifice located at the outlet of the Roto-Clone. A temperature controller, actuated by thermocouples located in the shell of the retort, maintains the burning section approximately 2 ft below the top of the kiln by control of the oil flow to the feeding mechanism.

FIG. 4 VIEW OF 50-TON PER DAY SHALE UNIT

RETORTING CHARACTERISTICS OF VARIOUS SHALES

Retorting characteristics of shales of different grades of oil content from the Green River formation vary widely. Thirty-gallon shale, as produced in the Bureau of Mines demonstration quarry operations, exhibits very little fusion in being processed in the Union retort, and the particles of shale discharged from the kiln retain the same general physical dimensions as the original shale particles entering the unit. On the other hand, shale on the order of 50 to 55 gal per ton is characterized by a semiplastic condition in the burning zone, and the clinker discharged overhead consists of semifused agglomerates which have been rolled into lumps by the overhead ash-discharging mechanism. Seventy-gallon shale exhibits even a more plastic condition in the burning zone, and the ash discharge on operation of this material is definitely clinkered and exhibits little resemblance to original particles charged to the unit.

Unlike the conventional retort or gasifying kiln, fusion of the ash is not considered a problem in operation of the Union retort. In this retort the plastic-ash zone is not subjected to the weight of the mass of solids, but is exposed to the free action of the scraping prongs of the ash-removal mechanism. The forces for motion far exceed those of the conventional retort where gravity provides the motivating power for downward motion.

In the retorting of shales, an appreciable portion of the oil produced leaves the unit as a mist in the gases drawn from the base of the unit. The character and extent of this mist varies also with the grade of shale being retorted. Fifty to fifty-five-gallon shale produces an effluent gas mixture containing a relatively small quantity of mist of large-particle diameter. This mist is fairly effectively agglomerated on simply passing through a blower by the action of the impeller. Thirty and seventy-gallon shales exhibit appreciable mist formation in their retorting operation, and particles of the mist are of a relatively small diameter, necessitating the use of special mist-agglomeration equipment, such as an Ultrasonic or Cottrell unit.

PRODUCTS FROM RETORTING 140,000 TONS OF TYPICAL OIL SHALE

Based on the retorting characteristics of shale from the Bureau of Mines, Rifle, Colo., demonstration mine, the products that would be derived from retorting 140,000 tons of 30-gal-per-ton oil shale have been estimated. These quantities are given in Table 4.

TABLE 4 PRODUCTS DERIVED FROM RETORTING 140,000 TONS OF 30-GAL PER TON OIL SHALE

		Gross heat of combustion, Billion Btu
Shale oil, bbl	100,000	603
Ash, tons	84,600	...
Fuel gas, Std. cu ft (gross heating value, 79 Btu Std. cu ft)	2,520,000,000	179

The energy content of the fuel gas produced in retorting is very considerable, amounting to 29.7 per cent of the total thermal energy available in the shale oil produced. This fuel will provide far more than the power necessary for mining operations and would provide opportunity for considerable outside power generation and industrial operations.

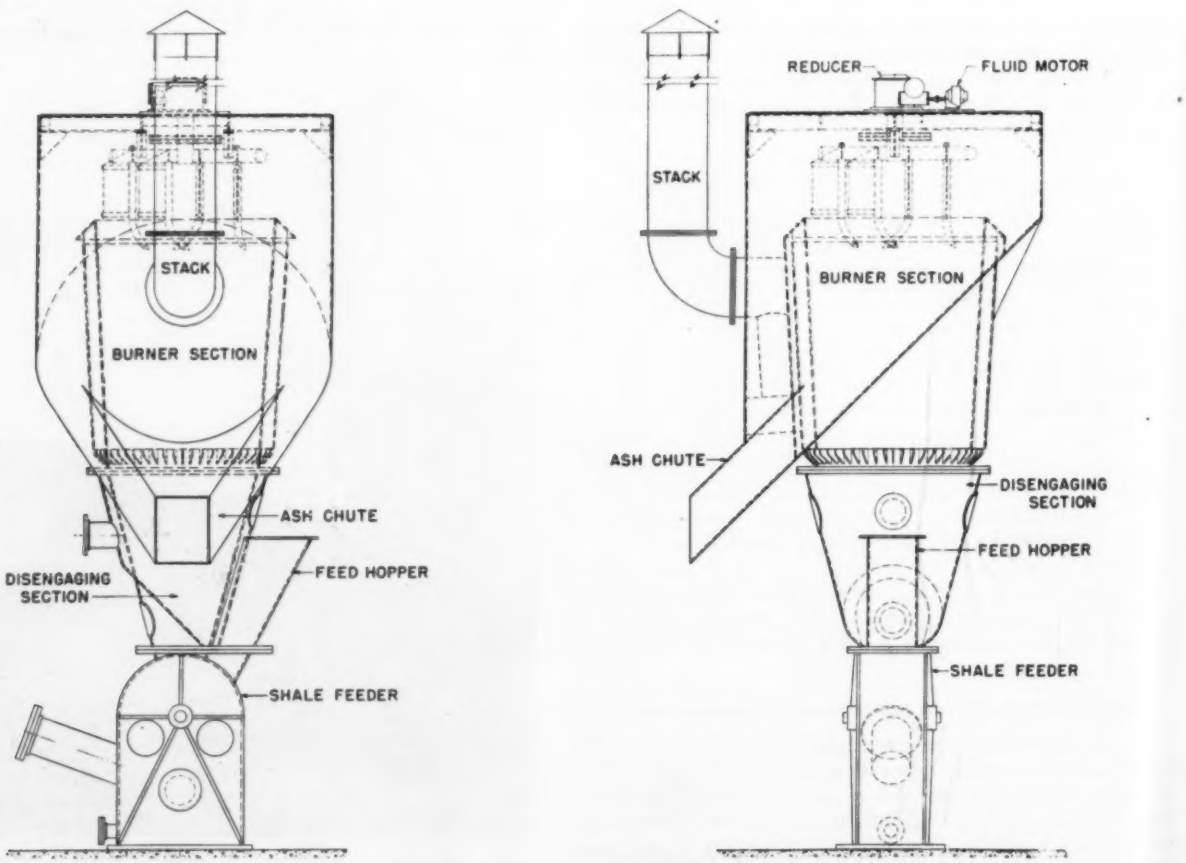

FIG. 5 ELEVATION DIAGRAMS OF 50-TON SHALE KILN, LOS ANGELES REFINERY

HEATING *and* VENTILATING *of the* MARTIN 202 AIRLINER

By ROBERT L. BERNER

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INTRODUCTION

BECAUSE passengers frequently consider comfort and convenience in selecting their modes of travel, many studies have been made and numerous articles have been written on the subject of designing cabin-conditioning systems for passenger comfort. This phase of design has been well covered elsewhere,[1,2] and will not be discussed here. Detail design of the system from the standpoint of such items as the calculation of heat loads, and the comparative advantages of various systems and equipment have been treated by Brod[3] and Heymann.[4] This paper will attempt to bring to light some of the practical problems which confront the designer in applying the principles expounded to the design of an airplane system, and will discuss the application of controls to secure the desired system performance.

PROBLEMS OF DESIGN

The heating and ventilating system of the Model 202 airplane is the result of an extensive research program, involving a comprehensive study of existing systems in airplanes, trains, and buses, in order to determine which system or combination of systems would be most desirable for a modern transport airplane.

The original airplane design was based upon a 30-passenger version, with considerable space allotted to cargo and baggage use. The heating and ventilating system included both "warm-wall" and forced-air features, with provision for recirculation of 75 per cent of the total volume of air supplied. Conditioned air was brought in through floor outlets at each inboard seat pedestal and through perforated panels above the hatrack. The warm-wall panels extended from the floor to the hatrack.

Many conferences with airline personnel followed. Gradually the concept of the airplane changed to a 40-passenger version with less emphasis on cargo and baggage area, and greater emphasis on serviceability. The airlines began to think in terms of 100 per cent fresh air instead of recirculation, and some thought was being given to possibilities of pressurization. Since pressurization would limit the cutouts required in the floor for heating outlets, and since some difficulty was being experienced with interchangeability of seats, due in some degree to the location of floor outlets, the system was revised to eliminate recirculation and to supply all air through ducts in the hatracks.

To maintain a comfortable passenger cabin, a system must be capable of supplying sufficient fresh air, and exhausting stale and smoke-laden air rapidly. It must accomplish this, however, while maintaining a stable and uniform cabin temperature, and without creating disturbing drafts. Since this is essentially a sensible rather than a strictly quantitative condition, it cannot be measured accurately with the usual instruments. For the same reason, opinion of what constitutes a comfortable condition may vary over a wide range. By accurate sampling of opinion, however, conditions may be established to produce a cabin which will satisfy a majority of the passengers.

To obtain these opinions, it was decided to construct a full-scale mock-up in which the heating and ventilating system could be installed. This mock-up included the fuselage area from the nose to the aft cabin bulkhead. Mock-up seats built to silhouette dimensions of the actual seats were installed to produce the baffle effects on the air flow and distribution in the cabin; and the interior was finished with the vinyl and cloth trim materials used in the airplane. The complete heating and ventilating system was also installed and sufficient instrumentation was provided to permit evaluation of the system design, as well as to permit an operational check of the components. External blowers and a cooling system were provided to furnish a source of air for simulated flight conditions, the combination of equipment providing air equivalent to speeds up to 250 mph at entering-air temperatures as low as 30 to 40 F. The blowers in the heating and ventilating system were used during simulated ground operation. Since the mock-up was located in an ambient temperature which was above those temperatures which would have been encountered in flight, cabin thermostats rated at 130 F were substituted for those normally used (70 F) during functional checks of the temperature-control system.

Co-ordination of air-flow data and temperature distribution taken from preliminary runs indicated an excessive temperature differential between cabin floor and ceiling, and it became apparent that a reduction of heated air introduced into the upper portion of the cabin would be desirable. Air-distribution tests indicated that the front and rear high-velocity outlets were delivering somewhat more air than those in the center of the cabin, but none of the flows were objectionably high or low. The upper warm-wall outlets were then sealed off in order to divert more air to the floor grilles.

To obtain a sampling of passenger opinion, two tests were run simulating "flights" with groups of people in the mock-up. For each of these tests, 40 people were seated in the mock-up and conditions were varied from "ground operation—loading," through "take-off and climb," "cruise," and "landing." At each stage of the flight the "passengers" were requested to note their reactions and observations on prepared questionnaires. From the data thus gathered it was possible to determine whether sufficient ventilation was provided, and the location and nature of any causes of passenger discomfort.

A summary of the questionnaires from the first test run indi-

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[1] "Factors Affecting Transport Air Conditioning and Pressurizing System Design," by P. E. R. Brice, *Aero Digest*, vol. 57, July, 1948, pp. 48–51, 109–110, and 112.

[2] "Human Factors in Air Transport Design," by R. A. McFarland, McGraw-Hill Book Company, Inc., New York, N. Y., 1946.

[3] "Heating and Ventilating for Transport Airplanes," by B. M. Brod, *Heating Piping and Air Conditioning*, vol. 18, Jan., 1946, pp. 124–129.

[4] "Selecting Aircraft Heating Equipment," by S. E. Heymann, *Industrial Aviation*, vol. 1, Sept., 1944, pp. 7–8, 10–12; Oct., 1944, pp. 11–12, 14–15, 96–97; Nov., 1944, pp. 32–34, 36, 38, and 70.

Contributed by the Heat Transfer Division and presented at the Spring Meeting, New London, Conn., May 2–4, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

cated that while ventilation, temperature stability, and air conditions were generally satisfactory, the presence of cold drafts near the floor caused almost universal complaint. Study and analysis of the system indicated that when cold air was introduced in the main intake scoop, with the cabin thermostats "satisfied," it entered the cabin unheated for some time before producing a response in the thermostats and starting the heater. This cold air exhausted directly toward the passengers' feet and ankles from the anemostat grilles and warm-wall exhaust slots, producing the cold drafts. The fore and aft cabinstats were relocated to provide better sensitivity. The questionnaires from the second test flight indicated that these measures had eliminated the presence of cold drafts near the floor.

Further tests, simulating conditions of ground operation, indicated that the flow of air from the individual cold-air nozzles was below that required by specifications, and that operation of the main ventilating blower produced a large decrease in static pressure near the heater combustion-air intake, with a decrease in combustion-air flow and "rich" burning of the heater. A blower was added to provide the necessary amount of cold air at the nozzles, and the combustion-air intake was relocated to a point aft of the main ventilating air blower. While in flight, when operating on ram air alone, this blower forms an obstacle which tends to lessen the amount of combustion air, but subsequent tests indicated that this loss was not sufficient to cause an excessively rich mixture.

GENERAL DESCRIPTION OF THE SYSTEM

The 202 heating and ventilating system is a combination of a

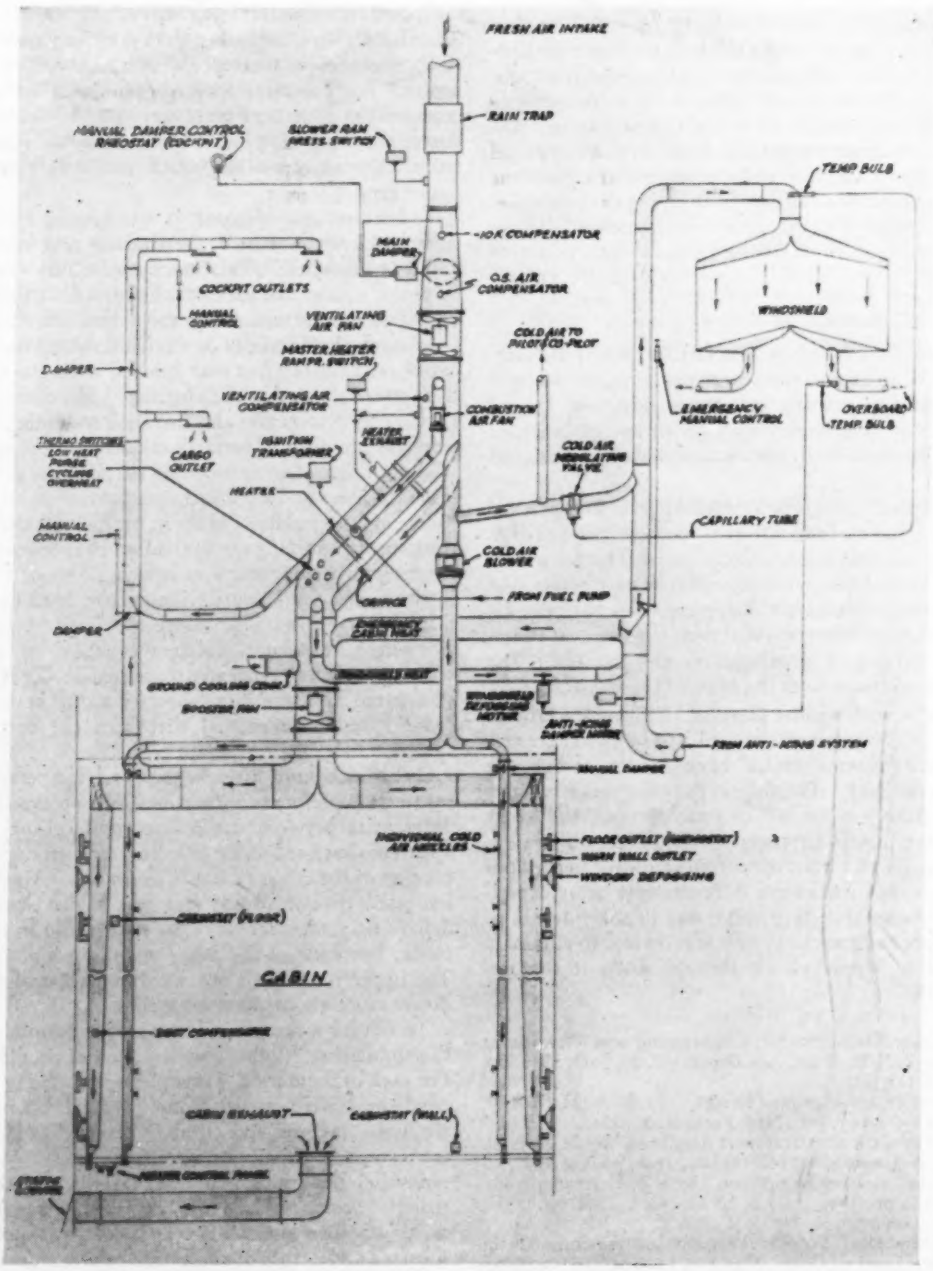

FIG. 1 SCHEMATIC OF HEATING AND VENTILATING SYSTEM

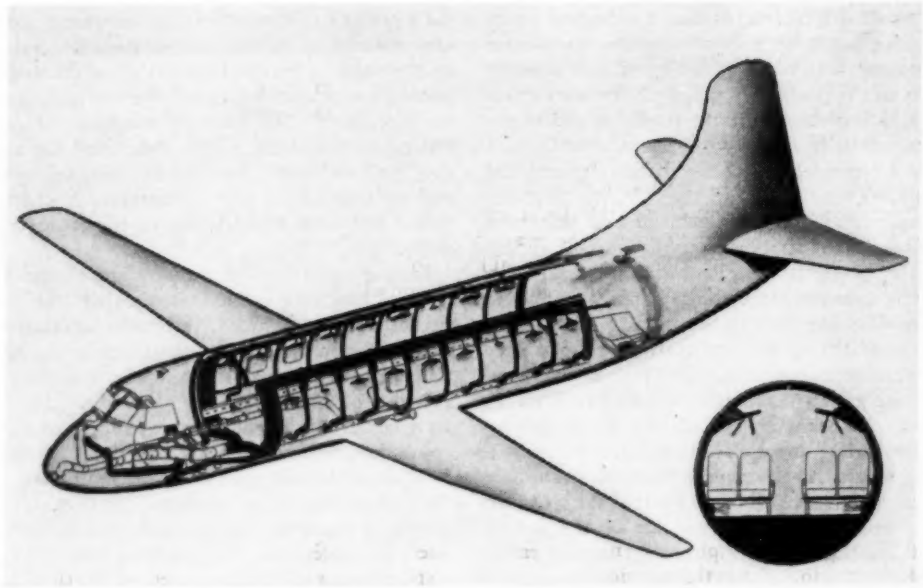

FIG. 2 ARRANGEMENT OF HEATING AND VENTILATING SYSTEM

forced-air-circulation system, a radiant-heat or warm-wall system, and an individual passenger fresh-air-supply system. It is shown schematically in Fig. 1 which represents the arrangement of the system as it now exists. The system consists of a gasoline-fired heater rated at 200,000 Btu per hr and four fans, namely, the main ventilating fan, the combustion-air fan, the cabin booster fan, and the fresh-air fan; together with a fuel system, operational and temperature controls, and duct work to distribute the heating and ventilating air.

The air for the system enters the airplane through a scoop located in the nose of the fuselage. A raintrap installed in the duct aft of the scoop will remove 90 per cent of the free water (rain or snow) from the entering air. The air is then directed to the main ventilating fan which supplies the pressure necessary to circulate the air through the airplane when it is on the ground. From this fan the air is ducted to the combustion heater. When heating is required, this heater will supply the required amount of heat demanded by the cabin control system. A by-pass around the heater prevents the air entering the cabin from becoming hot enough to be uncomfortable to the passengers. An orifice is provided in this by-pass line to control the amounts of air going through and by-passing the heater. From the heater the air is ducted to the cabin booster blower which provides additional pressure to the air. From here the duct branches, and goes up the wall on either side of the airplane to the hatracks.

All the heating and ventilating air for the passenger compartment is supplied from the ducts buried in each hatrack, the air coming from the two branch ducts previously mentioned. Air is bled from each hatrack duct to supply the forced-air-circulation system and the radiant-heat-transfer system. For the forced-air-circulation system this is accomplished by running ducts from the hatrack to the high-velocity diffuser grilles which are located on the side-wall step just above the floor and beneath each pair of seats. These grilles provide maximum air motion without objectionable drafts. Air for the radiant-heat-transfer system is supplied by short ducts attached to the hatrack duct which direct the air down the space formed by the fuselage frames, insulation, and interior trim. The arrangement of these ducts and the installation of the insulating material are shown in Figs. 2 and 3. The air from the radiant-heat-transfer system is then exhausted into the cabin through small louvers located in the side-wall step just above the floor. In the bays containing the windows, the air is ducted directly to a manifold installed over the space between the double-pane windows. The air flows through this space and is exhausted into the wall space below the window. It then flows down the wall space and is exhausted into the cabin by means of the small louvers previously mentioned. The use of the radiant-heat-

FIG. 3 INSTALLATION OF DUCTS AND THERMAL INSULATION

transfer system prevents the transfer of heat to the passengers from the outside during hot-weather operation and the transfer of heat from the passengers to the outside during cold-weather operation. The air in the passenger compartment flows aft to two exhaust grilles located in the ceiling at the aft end of the cabin. From there the air is ducted down the side walls to a static exhaust outlet located in the belly of the airplane and then flows overboard.

The lavatory, galley, and stewardess' station have their own source of air which is ducted directly from the hatrack supply duct to diffuser grilles located near the floor in these areas. The lavatory is separately exhausted into the cabin exhaust duct to prevent odors from diffusing into the cabin air. The galley (when located aft) and the stewardess' station are exhausted directly into the cabin-exhaust grilles. On versions of the airplane which have the galley located forward, the air from the galley is exhausted overboard by means of a static exhaust louver located in the ceiling directly above the galley.

The air for the cockpit compartment is taken from the left-hand branch of the main supply duct and mixed with higher-temperature air ducted from a point just aft of the heater. Temperature control of the mixed air is accomplished by means of a manually operated damper located at the junction of the two ducts. The mixed air is ducted forward to a manually controlled shutoff damper located beneath the cockpit floor. From here the air is ducted to two grilles located just above the floor forward of the pilot's and co-pilot's rudder pedals. All of the air is exhausted from the cockpit through an adjustable static exhaust louver located in the ceiling just forward of the cockpit door. On versions of the airplane which have the galley located forward, the cockpit exhaust is combined with the galley exhaust and ducted overboard through a static exhaust louver on the right side of the airplane.

The cargo compartment located between the cockpit and the passenger cabin obtains its air from the cockpit supply duct. This air is ducted to a diffuser grille located on the left-hand side of the forward bulkhead just above the floor. The air is exhausted from the cargo compartment by means of an adjustable grille located in the cockpit door. The air passes through this grille and is exhausted overboard through the cockpit static exhaust louver.

The individual passenger fresh-air supply provides a continuous source of outside air through individually controlled nozzles located in the hatrack above each passenger. This fresh air helps prevent the passengers from becoming airsick by providing a cone of odor-free air directed on their faces. Air for this system is taken from the main heating and ventilating system just forward of the heater. It is ducted through a blower and then up the side of the airplane to small ducts buried in each hatrack. The blower supplies sufficient pressure to the air to provide for ground operation of the system. At each seat location a pair of fresh-air nozzles takes off air from the small duct to provide adjustable outlets for each passenger. Fresh-air outlets are also provided in the lavatory and at the stewardess' station. The air from these outlets is ducted from the fresh-air duct in the hatrack.

OPERATING EXPERIENCE

Results of tests of the system in the mock-up indicated that it would produce a satisfactory cabin in flight. However, with any new design a normal amount of trouble is anticipated and the Model 202 proved to be no exception. Aside from difficulties with individual pieces of equipment, several major faults developed after the airplane had been placed in service. Due to the pressure relationship between the cabin and the outside of the airplane, air flow through the exhaust was unsatisfactory. A reverse scoop was added to correct this condition. With the advent of cold weather, the automatic temperature-control system failed to produce satisfactory control. First attempts at corrective action were based upon the assumption that the installation was at fault, and the corrections applied were not too successful. The difficulty was finally traced to an improper setting of a resistor which controlled the relative periods of the "on" and "off" portions of the temperature-control cycle, and to time lag in the cabinstats. A change in resistance values and some modification on the cabinstats eliminated the difficulty.

During operations of the airplane at altitudes considerably above those originally contemplated, the fuel system failed because of vapor lock. It became necessary to relocate the heater fuel pump to a point adjacent to the wing tank, in order to eliminate the long suction line, and this solution has corrected the difficulty. Some cases of fogging of the windshield have occurred when outside air temperatures were such that the cabin did not demand heat. At times it has been desirable to be able to heat the windshield without using the cabin heating or surface anti-icing systems. Studies are being made on methods to permit control of the windshield system independently of either of the foregoing systems.

Further experience has indicated the need for additional heat in the cockpit and the system has been modified accordingly. Studies have indicated that further improvements could be made to increase cockpit ventilation and lessen cockpit noises resulting from the arrangement of the system. To effect these improvements on recent versions, the original ventilators (manually controlled retractable type) have been replaced with individual fresh-air nozzles, and the adjustable static exhaust louver has been replaced by a connection leading to the galley exhaust.

OPERATIONAL AND TEMPERATURE CONTROLS

The normal operating controls for the heating and ventilating system are located on the stewardess' control panel. These controls consist of a three-position control switch, a cabin-temperature selector switch, a fuel-failure warning light, and a low-heat warning light. The three positions of the control switch are as follows:

1 Off and ground cooling (also for emergency operation in case of heater failure).
2 Automatic heating and ventilating (normal operation).
3 Manual heat (for emergency operation in case of control-system failure).

The cabin temperature-selector switch is used to select a cabin temperature in the range extending from 10 F above to 10 F below the 75 F design temperature. The fuel-failure warning light is actuated by a pressure switch so that the light will come on with fuel pressures less than 8 psi. The low-heat warning light will be on whenever the heater is not operating and during cold weather it is used as an indication of heater failure.

The cockpit-compartment temperature is controlled by the manual operation of two dampers. One damper is located at the junction of the ducts supplying the compartment and controls the temperature of the mixed air. The other is located in the mixed-air duct and controls the volume of the air supplied to the compartment.

Blower operation is controlled by a ram-pressure switch. Heater operation is controlled by a master ram-pressure switch and a fuel pressure switch, as well as by the temperature-control system. This system includes, in addition to the hostess' temperature selector, two cabin thermostats (cabinstats) two outside-air temperature compensators, and a warm-air temperature compensator ("ductstat") located in the ducts,

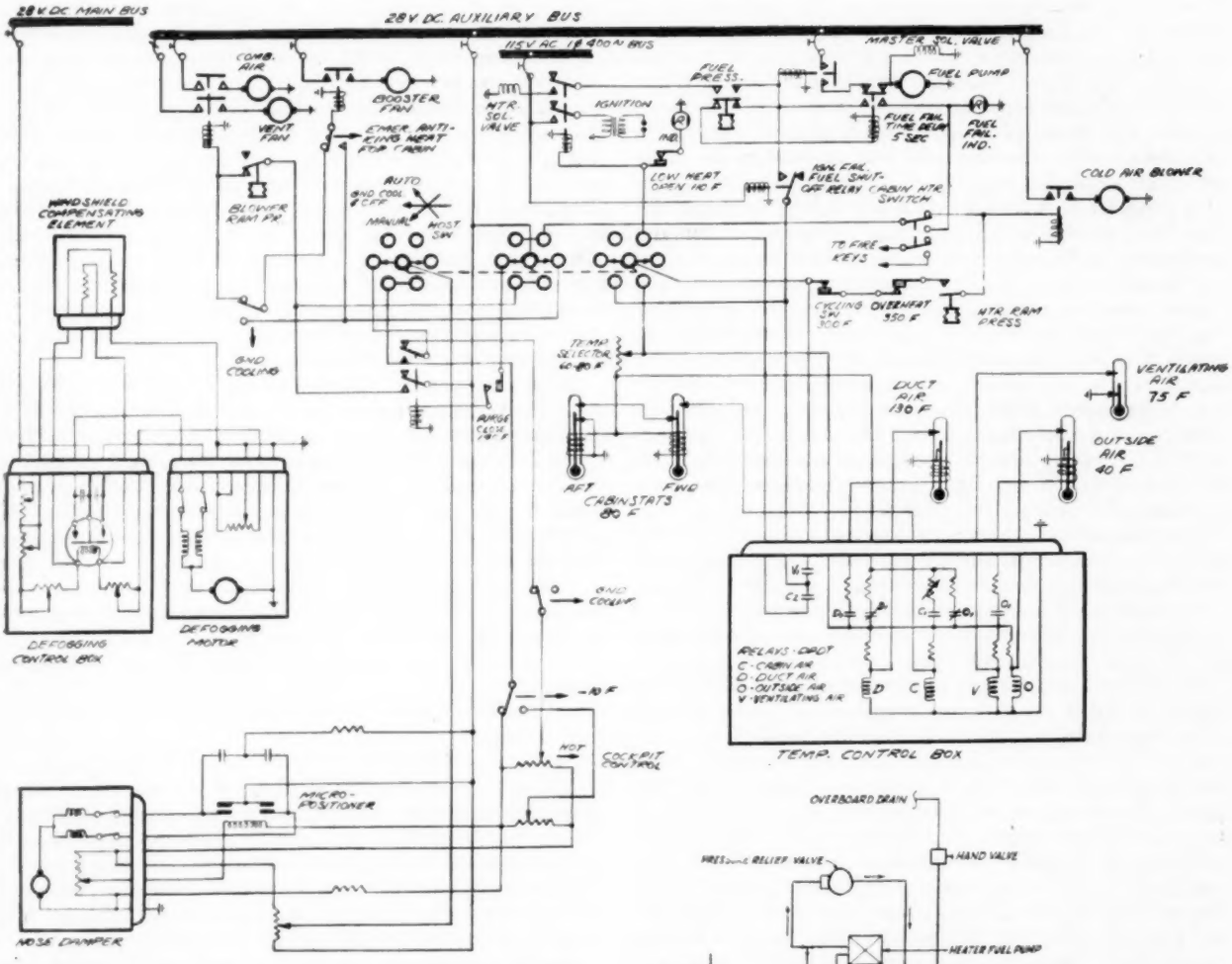

FIG. 4 SCHEMATIC WIRING DIAGRAM FOR MODEL 202 HEATING AND VENTILATING SYSTEM

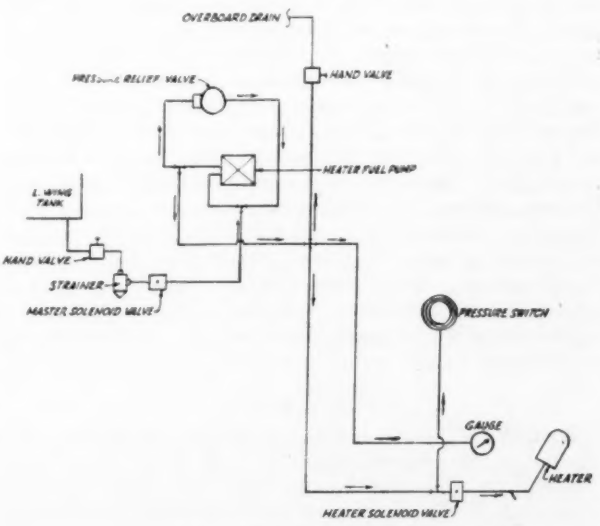

FIG. 5 FUEL SYSTEM

and four thermal switches also located in the ducts. The various operations are effected through a suitable system of electrical controls.

The function of the system controls may best be explained by following through a complete cycle of operation. Fig. 4 shows the arrangement of the control system, and Fig. 5 shows the arrangement of the fuel system. When, on the ground, the stewardess' selector is turned to the "automatic heating and ventilating" position, the main intake damper opens, all four fan circuits (main ventilating fan, combustion-air fan, cabin booster fan, and fresh-air fan) are energized, and the fans operate. When sufficient pressure is built up in the combustion-air and ventilating-air ducts, the normally open master ram-pressure switch is closed and the heater-ignition, fuel-pump, and solenoid-valve circuits (master valve at the fuel tank, and heater rapid-cycling valve at the heater) are energized and the heater operates.

When sufficient ram pressure has been built up during flight in the main intake duct, the normally closed heater-fan ram-pressure switch is opened, and the circuits to the heater fan, cabin booster fan, combustion-air fan and fresh-air fan are opened, stopping operation of these units. The system then operates on ram air pressure to move the heated air into the cabin supply ducts.

The thermostats located in the cabin and the duct-air and outside-air compensators consist of double-bulb mercury thermometers acting as temperature-operated mercury switches. The lower bulb is acted upon by the heat of the air in which it is located; the upper bulb is acted upon by the heat from a small resistance coil wound around it, the operation of the switch thus becoming a function of the total heat supplied by two sources.

The cabinstats act directly upon the heater-ignition and heater rapid-cycling valve. Thus when the total heat supplied drops to a point where the mercury switch is opened, these circuits are energized and the heater operates. The amount of heat supplied to the second bulbs of the duct-air and outside-air compensators is controlled by the selected cabin temperature.

There are two outside-air compensators. One of these, set at 40 F, serves as an anticipator. The other, set at 75 F, serves as a switch to turn off the heater if the outside-air temperature goes above 75 F. When the total heat supplied to either of these units is insufficient to maintain the switch in the closed position, the circuit to the cabinstats is adjusted through the control unit so that the amount of heat supplied by the cabinstat resistance coils is also decreased. Thus, even though the cabin temperature is satisfactory, a low duct temperature may cause the cabinstat switch to open (by decreasing the heat supplied by its resistance coil) and the heater to operate. In this manner, changes in cabin temperature, due to changes in incoming-air temperatures, are anticipated and forestalled, thus producing a more stable cabin temperature. When the cabinstat is once more satisfied and its switch closes, either because of a rise in cabin temperature or an increase in the amount of heat supplied by the heating element (due to an increase in incoming or duct air temperature), the circuits to the heater rapid-cycling valve and heater ignition are opened, and the heater ceases operation. The fuel pump continues to operate, by-passing fuel through the relief valve.

Four bimetallic-element thermal switches are located in the main duct, just aft of the heater outlet. The "low-heat" switch, normally closed, energizes the "low-heat light" circuit whenever the temperature in the duct drops to 110 F, incoming-air temperature is below 75 F, the selected temperature is such that the cabinstats demand heat, and the master ram-pressure switch and cycling switch are closed. The cycling switch, normally closed, opens whenever the heater-discharge temperature exceeds 300 F. This de-energizes the heater-ignition and fuel-system circuits, preventing heater operation until the temperature in the duct has dropped below 300 F. The switch then closes, re-energizing the circuits and permitting resumption of heater operation. The overheat and purge switches are described in the section on "Safety Controls."

A low-temperature thermostat, acting as a single-pole double-throw switch, is provided in the main intake duct. In the normal position, the proper damper motor-positioning circuits are connected to allow the main intake damper to open fully. When the ambient, or incoming-air temperature drops to —10 F, the switch is moved to the other pole, connecting the positioning circuits to move the damper to a predetermined partially closed position. In this manner, the amount of air entering the system at low temperature is limited to that which can be heated sufficiently to assure a mimimum cabin temperature still in the comfort zone.

SAFETY CONTROLS

Controls for the safe operation of the heating system include the master ram-pressure switch, an overheat switch, a heater purge switch, a fuel pressure-time relay, and an ignition power-failure relay. The first two of these are connected electrically in series with the cycling switch. The low-heat, purge, cycling, and overheat switches are located downstream of the heater so that they "see" the heater, and therefore are subject to radiant heat.

The master ram-pressure switch is connected to both the ventilating-air and combustion-air intake ducts, and provides protection against failure of either air supply. Air pressure from operation of the ventilating-air and combustion-air blowers or from ram air during flight must be present at both tubing connections to this switch, or the air will by-pass through the tubing, and the switch will open, breaking the heater-ignition and fuel circuits.

During initial starting and in case of manual operation of the system, the heater will be cycled by the cycling switch. In the event of failure of this switch, the additional overheat switch, normally closed, and set to open on temperatures in excess of 350 F, is provided to perform the same function.

The heater-purge switch, normally open, closes when the duct temperature rises to 140 F, and remains closed until the duct temperature drops below that value. When closed, this switch energizes the heater-purge and damper-control relay with the stewardess' selector in the off position, permitting the main intake damper to remain open, and all blowers to operate. Thus, if the selector switch is placed in the off position while the duct temperature is above 140 F, the main damper will remain open, all blowers will operate for a short time to purge the system of unburned fuel remaining between the heater nozzle and the rapid-cycling valve, and the system will be cooled to a maximum temperature of 140 F before complete shutoff occurs.

In the event of a fuel-pump or fuel-line failure, when sufficient fuel pressure has not been built up in a predetermined interval, a fuel-failure time-delay relay is energized, opening the fuel and ignition circuits, stopping heater operation, and closing the master solenoid fuel valve to prevent leaking or loss of fuel. At the same time the fuel-failure light at the stewardess' station is turned on, and will stay on until the control switch is turned off.

Power for heater ignition is provided from a separate 115-volt a-c source which also supplies the airplane instrument system. In order to guard against attempts to operate the heater if the a-c inverters are not turned on or should fail, a relay has been incorporated in the fuel-system circuit, and is arranged to shut off the fuel supply in the event of ignition power failure.

SPECIAL AND EMERGENCY CONTROLS

With the control switch in the "off and ground cooling" position, the entire heating and ventilating system is denergized. In the event that ground-conditioning equipment is connected to the airplane, this connection will actuate a double-pole double-throw switch, disconnecting the normal position circuits, and completing circuits to move the intake damper to the fully closed position and to operate the cabin booster fan.

In order to prevent fogging of the windshield, heated air is supplied to the windshield by means of the windshield anti-icing system. The heated air is bled from the main heating and ventilating system just aft of the heater but forward of the by-pass around the heater. The air is then ducted through a modulating valve to the anti-icing duct. The modulating valve is controlled by a thermal element located in the windshield exhaust duct to maintain a 95 F exhaust temperature.

This windshield defogging air is supplemented by air flow from the anti-icing system when it is in operation. In order to prevent windshield defogging air (supplied by the cabin heating system) from exhausting through the anti-icing system, a valve is provided in the anti-icing duct leading to the windshield. This valve is actuated by any of the anti-icing heater switches, and is open only when one or more of the anti-icing heaters are turned on.

It is necessary to limit the air temperature entering the windshield to 200 F to prevent overheating of the vinyl layer in the inner windshield pane. This is accomplished by mixing cold air from the cabin ventilating-air intake duct with the main stream of heated air. The quantity of cold air bled into the main duct is controlled by a valve in the cold-air duct. This valve is actuated by a fluid-filled bellows which expands or contracts with changes in temperature, sensed by a fluid-filled bulb located in the duct near the entrance to the wind-shield.

In the event of failure of the cabin temperature-control system or its components, the heater may be operated on "manual" control. With the stewardess' selector in the "manual heat"

(*Continued on page 662*)

MODERN RADIATION-DETECTION INSTRUMENTS *for* HEALTH PROTECTION

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THE rapidly increasing use of atomic energy and radiochemistry is demanding more and more assistance from almost all types of engineering. Although the engineer may not be directly concerned with radioactivity, the peculiar properties of radioactive elements are such that he will find a short introduction to the radioactive hazards and their detection useful. In this new field the hazards are new—their recognition difficult.

The purpose of this article is to set forth in simple terms the physical nature of the hazardous radiations and to describe the available tools used to measure them.

NATURE OF THE PARTICLES TO BE DETECTED

Alpha Particles. Alpha particles, which are helium atoms having a double positive charge, are ejected from radioactive nuclei with energies up to 10 Mev (million electron volts). These particles produce dense ionization as they pass through matter and so lose their energy in a very short distance. Almost all alpha particles lose their entire energy in passing through about 3 in. of air. This is the equivalent of passing through 0.004 in. of a material with a density of 1.0. Thus detectors for alpha particles must have a wall much thinner than 0.004 in. especially if the material used has a high density. In addition the particles may pass through air or other material before entering the detector and hence lose a large portion of their initial energy. Coatings of dust and foreign material such as moisture and oil also tend to make the particles more difficult to detect. Alpha particles are most damaging when emitted from ingested or inhaled radioactive materials.

Beta Particles. Beta particles are high-speed electrons emitted from radioactive nuclei with energies from 0 to 5 Mev. They do not expend their energy in producing ionization as freely as alpha particles and as a result may travel through as much as 10 to 100 ft of air before losing all their energy. This distance in air corresponds to a penetration of about 1.25 in. of a substance with a density of 1.0. Beta particles are somewhat easier to detect than alpha particles but many substances eject low-energy beta rays and it is necessary to restrict the detector walls to a few thousandths of an inch. Since the beta particles do not produce as dense ionization as alpha particles (roughly a factor of 1000) more sensitive instruments are necessary for their detection.

Gamma Rays. Gamma rays are not particles like alpha and beta radiations but are electromagnetic radiations emitted from radioactive nuclei with the velocity of light. Gamma radiation is usually accompanied by the emission of alpha or beta particles, but sometimes only gamma rays are emitted. Gamma radiation does not have a definite range as do the alpha and beta particles. The intensity of gamma radiation decreases exponentially as it passes through matter. Gamma-ray absorption therefore is measured by the layer thickness required to decrease intensity by one half, the so-called "half-value thickness." Gamma radiation will sometimes be detectable at a distance of several hundred feet, the limit being set usually by the fact that, as for all unfocused radiation, the intensity falls also inversely with the square of the distance from the source. Gamma rays are detected indirectly, for when they react with matter and lose energy, a high-speed electron is produced which in turn acts like a beta ray in producing ionization. X rays and gamma rays differ only by the method of production.

With the available methods of detection it is impossible to distinguish between beta particles and gamma rays because the energy ranges of the two overlap. However, for health hazard surveys the two are detected by a single detector and classified into "hard" and "soft" radiations; soft radiation causing only superficial body damage, and hard radiation causing damage deep in the body structure.

Neutrons. Neutrons are seldom encountered in laboratory work with radioisotopes and their main source is nuclear reactors. Neutrons are particles having no charge, hence they cannot be detected directly by ionization methods. The most used method for detection is to allow the neutrons to strike a boron coated surface and then record the alpha particles which are emitted by the action of the neutrons on the boron. Neutrons have very great penetrating power.

RADIATION DETECTORS

Nearly all the common radiation detectors depend upon the phenomena of ionization. Most detectors are air-filled or gas-filled and the gas or air is ionized, either by the radiation directly or indirectly by the production of a particle capable of producing ionization.

Ionization Chambers. The simplest of all detectors, and historically the earliest, is the ionization chamber, see Fig. 1. In a typical form it consists of a closed cylindrical tube about 4 in. in diam and 5 in. long, with a small rod passing through the center of volume but well insulated, electrically, from the box itself. The box must be made of conducting material or coated with some conductor such as carbon or graphite. The center rod or "collectrode" must also be a conductor or have a conducting coating. If a potential is established between the cylinder and the collectrode the charged particles produced by ionization of gas in the chamber volume will migrate toward the cylinder wall or the collectrode under the influence of the electrostatic field. If then the chamber is placed in a radiation

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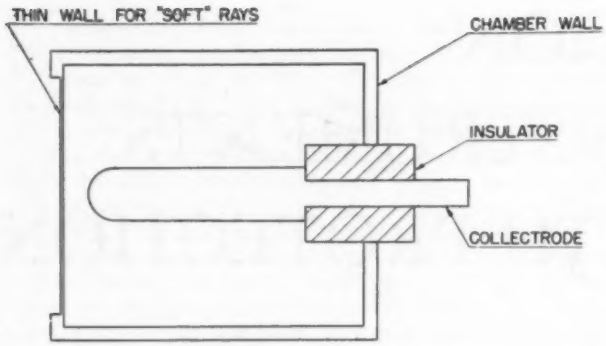

FIG. 1 IONIZATION CHAMBER

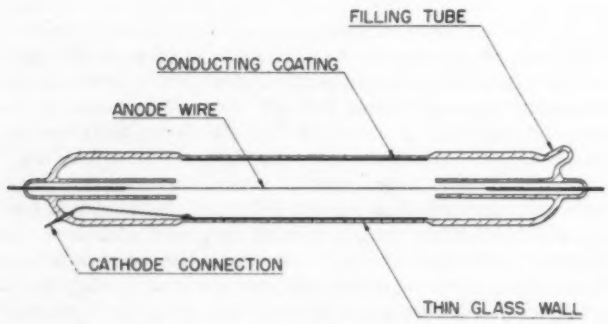

FIG. 2 GEIGER-MÜLLER TUBE

field the current flowing between the electrodes is a measure of the strength of the radiation-field intensity. The voltage across the chamber should be from 60 to 300 volts, depending on the physical design of the chamber and the radiation intensity. The ionization current across the chamber will usually be from 10^{-13} amp to 10^{-10} amp. This current may be measured in two ways. First, a sensitive direct-current amplifier may be employed to read this current directly, and second, the current may charge a capacitor and the resultant capacitor voltage read after an elapsed time.

Ionization chambers are used mostly for detecting beta and gamma radiation and sometimes for detecting alpha particles from surface "contamination." Boron-coated chambers are sometimes employed for measuring neutron intensities. Ionization-chamber instruments can be made less sensitive than other detectors to wave-length variations of gamma and x rays. Therefore, they have been chosen as the basis for the standardization of radiation measurements.

Geiger-Müller Tubes. Geiger-Müller tubes, Geiger tubes, or GM tubes as they are commonly called are very sensitive devices and with them single electrons can be detected. The most common design consists of a glass tube $^1/_2$ to 1 in. in diam with a 0.002 to 0.005-in. wire suspended axially through the tube, see Fig. 2. The inside of the tube is coated with conducting material. The device is pumped and permanently filled with a rare gas to about $^1/_{20}$ of an atmosphere. A potential of 1000 volts is produced between the wall and the central wire (the wire is made positive). In action the tube is a trigger device. If a free electron is formed within the tube it is drawn toward the positive central wire. Under the influence of the high voltage gradient near the wire the electron soon has sufficient energy to ionize a neutral gas molecule on collision. Then the two free electrons accelerate toward the center wire and again cause ionization by colliding with other gas molecules; this process is repeated again and again. The resulting current to the center wire may consist of several million electrons. The output of such a counter consists of a sharp electrical pulse of constant amplitude, independent of the initiating ionization. Since by the gas amplification the charge per pulse is large, the voltage pulses are one to twenty volts in amplitude, and easily used in simple electronic amplifiers. These amplified pulses can be made to operate a mechanical counter or operate an averaging or counting rate circuit, wherein a meter is made to read the number of "counts" per minute.

Geiger tubes are highly sensitive and hence are very useful at low levels of radiation intensity such as locating lost or misplaced radioactive material, or locating leaks and contaminated areas, but at high radiation levels the tubes become useless or even dangerously misleading. This is because they require an appreciable time after discharge to recover sensitivity. Above a certain radiation intensity their indications become weaker and less frequent, and may give an entirely false sense of security.

Geiger tubes with thin glass walls (0.005 to 0.007 in.) are used for the detection of soft radiation. If such a counter is equipped with a movable shield of, say, $^1/_{16}$-in-thick brass it becomes possible to distinguish between hard and soft radiations.

Proportional Counters. Proportional counters, in essence, are modified Geiger tubes, the difference being that the signal out of this detector is proportional to the initial ionization produced in the counter by the ionizing particle. If a Geiger counter is operated at a potential just below the Geiger region the device will not produce pulses of equal size for all ionizing rays, but the size of the pulses will be proportional to the initiating ionization. Thus alpha particles which produce ionization about a thousand times as dense as beta particles will produce a corresponding larger pulse from a proportional counter. The use of a pulse size discriminator permits the registering of the large alpha pulses while ignoring the small pulses from beta and gamma radiations.

The construction of the tube is similar to GM tubes except that by reducing the wire to 0.001 in. in diam and using a polarizing potential of about 2500 volts, the counter can be made to operate satisfactorily in air at atmospheric pressure. The use of an open-sided tube allows alpha particles to enter the counting volume easily, but usually a thin film of plastic (0.001 to 0.0005 in. thick) is employed to maintain the counting volume dry and dust-free. Pancake-type probes with several collecting wires are sometimes used to permit scanning of larger areas.

Miscellaneous Types of Detectors. Photographic-type films are often used to detect nuclear radiations. These films are sensitive to all radiations that produce ionization directly or indirectly and are used to accumulate a record of the user's exposure over a relatively long period of time. At present they are the only type of detector that operates by the energy of the radiation directly, although recent investigations show that the color of some organic crystals can be changed by nuclear radiations, to give similar information.

Crystals such as diamonds and zinc sulphide can be made to count in the same manner as GM tubes and perhaps a suitable crystal will eventually replace the GM tube detector.

Scintillation counters use a phosphor material in which the incident radiations produce very weak flashes of light which can be detected by a photomultiplier tube. However, this type of detector is not yet ready to take an important place in health physics work.

DETECTING INSTRUMENTS

The instruments are divided into the following two groups:

1 Direct reading rate meters. Instruments that fall into this classification are those which give a direct indication of the radiation intensity. The indicator may be a meter, earphones, a loud-speaker, or a flashing neon lamp.

2 Accumulator-type instruments. These instruments indicate the quantity of radiation received during some time interval. External timing devices are used, the time interval for normal use varying from a few seconds to a week or more depending on the function for which the instrument is designed. This type of instrument is not well suited for rate or intensity measurement because it requires excessive operation time and is, of course, incapable of giving instantaneous values, whereas rate meters give data which are easily summed to give total dose, if the intensity does not fluctuate too wildly.

FIG. 3 TYPICAL IONIZATION-CHAMBER INSTRUMENT

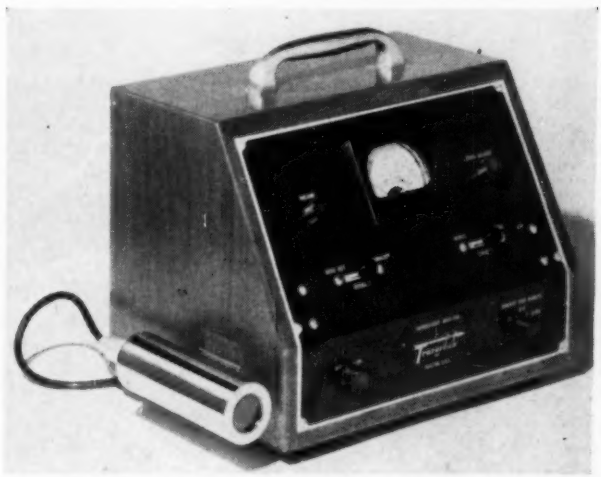

FIG. 4 TYPICAL GEIGER-MÜLLER TUBE INSTRUMENT

RATE METERS

Ionization-Chamber Instruments. These instruments are very diverse in physical form but they all have an ion chamber detector and a sensitive d-c amplifier to measure the chamber current and drive an indicating meter. See Fig. 3. The amplifier must be extremely sensitive—usually giving a full-scale meter deflection for about 10^{-12} amp of chamber current. The detectors may be simple air-filled chambers or a special gas may be used. Some are hermetically sealed to permit reliable operation at various atmospheric pressures as in aircraft or submarines. The chamber may be equipped with a thin window and a shield to permit distinguishing between hard and soft radiations. Some have very thin windows to permit alpha-particle detection. The amplifiers may be simple one-tube circuits or they may have as many as 10 tubes including power-supply-regulating circuits. Feedback amplifiers are sometimes used to give stability, linearity, and rapid response.

The entire instrument may be waterproofed to insure satisfactory operation under severe weather conditions. This type of instrument is the most popular for health survey use, for it can be made with a wide range of sensitivities and can be used to measure alpha, beta, or gamma radiations.

Geiger-Counter Instruments. GM tube instruments are available in a wide variety of forms, see Fig. 4. The simple instruments contain only a high-voltage battery supply, GM tube, and a pair of earphones. These instruments are not satisfactory for most uses. With the addition of an amplifier to drive the earphones the instrument becomes very useful in finding mislaid radioactive materials, locating contaminated spots, and with the aid of a reference radioactive comparison standard, good estimations of low-level intensities can be made. On other instruments a blinking neon light may replace the earphone or provide an additional indicator of the radiation intensity. The more complex instruments employ an amplifier and an averaging circuit to give a meter indication of the radiation field strength. These instruments usually have provision for earphones. The GM tube is usually mounted on a cable to permit easy scanning of large areas.

Since the best GM tubes at present require an operating potential of nearly 1000 volts the instruments are bulky. Battery packs are expensive and it is the high-voltage batteries that give the most trouble with this type of instrument.

Because Geiger tubes are the most sensitive radiation detectors, these instruments are invaluable for detecting small amounts of beta and gamma radiations. Very thin-walled (mica window) Geiger tubes are used for alpha-particle detection but the tubes are very fragile and seldom used in portable survey instruments.

Proportional Counter Instruments. It was pointed out that proportional counters will detect alpha particles in the presence of large numbers of beta particles and gamma rays; hence this type of instrument is extremely useful where mixed radiation is encountered. The principle of operation is similar to that of the Geiger counter except that a higher-gain amplifier is used and the counter has 2500 volts operating potential. Development of satisfactory lightweight, inexpensive, and stable high-voltage supplies will make this type of instrument more popular. The proportional counter probe is usually a multiwire arrangement to allow checking large areas. Some types of this instrument have a separate high-voltage supply which is used to charge a condenser periodically. Modification of the instrument probe to include a boron coating permits use of the instrument for detecting neutrons.

ACCUMULATOR-TYPE INSTRUMENTS

Sentinels. These are laboratory instruments designed to monitor working areas for radiation. The meter reads the total amount of radiation received by the instrument. They usually have ionization-chamber detectors and a sensitive vacuum-tube voltmeter to measure the accumulated charge and drive a meter. In addition, the instruments may have provisions for connecting a recording device so that permanent records may be obtained. The instruments may have provisions for an alarm so that a warning may be sounded if a preset amount of radiation is exceeded.

Quartz-Fiber Electroscopes. The quartz-fiber electroscope consists in one form of a quartz fiber, 0.0001 in. in diam and $^1/_2$ in. long, supported on one end and placed near a metal plate. The elements are well insulated and the fiber has a conducting

FIG. 5 POCKET ALARMS

FIG. 6 FILM BADGES

gold coating. If a voltage is produced between the two elements the fiber will move under the pressure of the electrostatic field. The instrument is so designed that radiation entering the ionization chamber discharges the voltage across the device and the fiber is displaced. A built-in microscope is used to observe the motion of the fiber across a calibrated reticle in the microscope eyepiece.

Dosimeters. Dosimeters are a form of quartz-fiber electroscope about the size of a fountain pen and designed to be worn in a shirt pocket. They contain no batteries, but must be "charged" by a charger unit each time the device is used. The microscope reticle is marked so that the accumulated radiation can be read by looking through the eyepiece. The "tolerance" is usually one half of full deflection. They are worn by the person while at work in radiated areas; thus the worker may keep a check on his exposure.

Pocket Chambers. These are devices similar to the dosimeters, but do not have a built-in electroscope. Pocket chambers are read by a special reading device. These instruments are usually carried by the worker for his full working period and then read when he leaves work. They are used for obtaining records of individual exposure for safety and legal purposes.

Pocket Alarms. These are small battery-operated instruments carried on the belt which give an audible alarm when a tolerance limit has been reached, see Fig. 5. They are particularly valuable where the radiation intensity is unknown and may be subject to considerable variation, or where the worker has to devote full attention to an operation.

These instruments consist of an ionization chamber and condenser with a single-tube electrometer amplifier which operates the alarm circuit.

Film Badges and Rings. These badges usually serve as plant identification passes and contain a strip of photographic type film, see Fig. 6. The film is usually worn for a week or two and then developed as one develops x-ray film. The degree of darkening of the negative indicates the total radiation received by the individual. If a lead shield covers part of the film both hard and soft radiation can be measured by the same badge.

Finger rings with a recess for film are favored by chemists or other workers who handle radioactive material.

SPECIAL INSTRUMENTS

Special instruments available for monitoring purposes are hand counters, foot counters, and air monitors. Hand and foot counters are used to check personnel for contamination as they leave working areas or to insure that contamination is not brought into "clean" laboratories. Air monitors are used to record the amount of radiation carried in the air as gases or as dust from machining or handling operations.

FIG. 7 PORTABLE-BATTERY-OPERATED IONIZATION-CHAMBER INSTRUMENT

FIG. 8 PORTABLE-BATTERY-OPERATED GEIGER

TECHNICAL *and* MANAGEMENT FACTORS *in* REGIONAL INDUSTRY

By GRAHAM W. PARKER

INDUSTRIAL CONSULTANT, NEW YORK, N. Y. MEMBER ASME

A SUBJECT of major national interest, which concerns the engineer as well as the civic planner and the industrial executive, is the expansion of regional manufacturing in the South, the Southwest, the Pacific West, and other economic divisions of our country.

We have all had occasion to consider this subject from one viewpoint or another, calling it the trend to branch plants, decentralization, dispersion, or simply the growth of the West. Back in 1937, a young graduate student at McGill University in Canada, compiled what was to the author's knowledge at that time the first bibliography on the subject and listed over 600 titles, many of them devoted to decentralization from the social point of view, while others were concerned solely with the technical aspects of plant location (1).[1] In the 12 years since that time the literature and of course the subject itself have grown immensely.

There have been nationwide studies of the shifts in industry, such as those made by the Lyme Foundation in 1946, and by the National Industrial Conference Board in 1948; the numerous community-development programs and the studies made by various regional-planning associations, each concerned with its own geographical area (2); there was the doctrine of "regional deficiencies," expressed in an engineering report made for state authorities about 8 years ago; and finally, there have been the many expressions of the national, or strategic, point of view, which was concisely stated recently by R. E. Gillmor, vice-chairman of the National Security Resources Board, when he said (3):

"Many large industries have learned by experience that there is a limit to the size and complexity beyond which an industrial organization cannot be developed in a single unit without incurring diminishing returns. It is for this reason that so many organizations have decentralized into a multiplicity of autonomous units, each a complete business in itself. . . Decentralization of industry is essential not only for protection against loss of productivity by enemy attack, but also for the higher efficiency that is necessary to increase productivity."

In considering any approach to the subject, we must remember that, generally, industry is growing in all parts of the United States and that, thanks to a number of factors, it has become both possible and profitable to manufacture a much greater variety of goods within each economic region of our country. A rough measure of this growth is obtained by comparing new plant construction of the period 1938–1940, with the period 1946–1948, in a regional grouping which we find useful, as shown in Table 1.

These figures, which bring into contrast the relative rates of growth of the several regional areas, include of course both the establishment of plants by purely local enterprise and the construction of branch plants by national manufacturers. This latter phase is dealt with more specifically in the present paper, although the two phases are not strictly separate, and many of the influences which affect one apply equally to the other.

TABLE 1 INDUSTRIAL CONSTRUCTION BY REGIONS[a]

(In millions of dollars)

	Year			Year		
	1938	1939	1940	1946	1947	1948
Total U. S.	152.0	282.9	594.1	1113.2	862.2	1095.6
New England	10.9	18.1	34.7	49.3	42.1	38.5
Atlantic	46.9	93.6	123.0	155.6	215.8	175.1
North Central	30.1	62.3	178.6	207.2	142.2	227.6
Mid-Continent	17.6	18.3	38.3	131.1	115.1	124.0
Southeast	20.3	50.4	102.6	253.2	107.1	165.7
Southwest	15.3	22.4	67.3	158.1	146.8	167.1
Pacific West	10.9	16.9	49.6	158.7	93.1	197.6

[a] Compiled from reports of construction contracts awarded in each state for private industrial buildings (9).

The term "branch plant" can be taken conveniently to include the extension of the manufacturing activities of a company from its traditional center to additional locations which are new for the particular industry involved. For example, many long-established products are being made today in Santa Clara County, Calif., and in Fairfield County, Conn., that were not made in either area 10 years ago.

It is certain that the branch plants of eastern companies have had an important but by no means overwhelming role in the growth of industry in the Southwest and Pacific West. In the same way, branch plants of Detroit, Chicago, and Cleveland manufacturers have contributed a good deal to the postwar economy of many New England communities (4). It is our purpose in this paper to identify and to appraise rapidly some of the engineering techniques which have facilitated and encouraged the branch-plant trend in regional manufacturing.

IMPROVEMENT IN MACHINERY

The feasibility of branch-plant production has increased as a direct function of the rise of the automatic precision machine, and much credit for multilocation manufacturing must be given to the last two generations of machine designers who have changed the conception of manufacturing itself through their development of automatic production units.

Nineteenth-century machine design supplemented and extended the human arm. The emphasis was on using high manual skill to produce more than could be done by the applied skill of the hand unaided. Many machines required greater skill and practice on the part of the workman than were required by the same operation performed manually. The power loom was harder to operate than the hand loom. Mechanical conception of this kind was the foundation of modern industry and encouraged the building up of large pools of

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Management Division and presented at the Semi-Annual Meeting, San Francisco, Calif., June 27–30, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

labor in certain locations, traditionally skilled and specialized in the operation of certain machines.

For some years now a different trend of design or redesign has been coming forward, i.e., designing not to increase the output of the skilled hand but rather to reduce or eliminate the need for skill. The impact of this trend is broad, and its effect in spreading out manufacture has already been great. It is best visualized by taking case examples, starting with the generally familiar machine-shop practice. In the usual machine shop, for instance, centerless grinding has been a good skilled job. Today a manufacturer of a centerless grinder can point out that the skill of the operator is the least important factor: "Operation of this machine involves nothing more than placing the work in loading chutes. Loading, unloading, and even size control are completely automatic. One operator —an unskilled one at that—can handle as many as six machines at once."

Other common tools of the machine shop have undergone similar evolution. Thus we have electric-cycle turret lathes and vertical boring mills which, once set up for the job to be done, require only loading and unloading of parts and the watching of a few controls. Another example is found in the so-called "transfer" machines, as recently introduced in the automobile industry. Each transfer machine represents a combination of automatic conveyer and production operations that were performed previously in batteries of separate machines. Thus there is the Kearney & Trecker planer-miller which both rough-mills and finish-mills cylinder-head surfaces, with a shuttle-type fixture that has five automatic functions as follows:

1 Lock work for milling.
2 Move work progressively through the cutting cycle.
3 Unclamp work at end of cut.
4 Return to starting point to pick up next pair of blocks.
5 Unload finished blocks.

Operation is at a speed of 350 fpm, with a feed of 38 ipm.

Then there is the transfer drill, built by the Cross Company, which performs 14 operations on 28 gearshift housings at a time, about which it has been commented (5): "A minimum of physical and mental effort is required of the attendant who merely pushes the control button and the machine takes over, automatically transferring, locating, clamping and machining the parts progressively two at a time."

Even in the textile industry, whose basic machines have long been unchanged, an evolution in design is appearing, e.g., the simple machines which still require much labor, more or less dexterous or skilled, progressively may be replaced by truly automatic production machines. The Abbott automatic winder, at which the operator stays seated and loads and unloads the work on a continuing cycle, instead of hurrying back and forth the length of a long machine face, was a forerunner in this textile trend. The most spectacular example is the Warner & Swasey shuttleless loom, which has been designed expressly not to be another loom for the skilled weaver, but to be a "weaving machine" for an ordinary machine hand to operate.

Along the same lines are the great number of filling and packaging machines which require only a few relatively unskilled feeders of material and a set-up man or two for a roomfull of machinery. It will be appreciated that what all these machines have in common, in so far as labor is concerned, is the characteristic that they can be put down in any location and operated just about as efficiently there as in the largest industrial center.

AUTOMATIC CONTROLS

Another factor reducing the need for highly skilled centralized labor and enabling the setup of a unit process in almost any location has been the development of automatic controls, automatic measurement instruments, and servomechanisms. The late A. C. Klein, chief engineer of the Manhattan Project, gave a vivid example of this by pointing out that "most of the operations at Oak Ridge were carried on by girls having a grammar-school or only part of a high-school education. Their work was systematized to be within the reach of their capabilities by providing automatic control equipment of a complexity never before developed, so that all they had to do to control the operation was to keep watch on a few meters and to operate corresponding dials."

The chemical engineer, who is familiar with temperature and flow controls, and the machine-shop man, who is more acquainted with automatic cycles or automatic positioning controllers, can each get a broader idea of the interrelation of his respective specialty from two books which may be mentioned: Eckman's "Principles of Industrial Process Control" (6), and Dr. Wiener "Cybernetics," which has attracted wide comment in the last 6 months (7). Dr. Wiener expressed the ultimate simplification to be expected from automatic controls when he said:

"The automatic factory, the assembly line without human agents, are only so far ahead of us as is limited by our willingness to put such a degree of effort into their engineering as was spent, for example, in the development of the technique of radar . . ."

PRODUCT DESIGN

Modern engineering contributes to industrial extension not only through its effect on machines of production but also through the evolution in the design of many end products. The consulting industrial designer, who has come into his own as a major profession only in the last decade, has done much to hasten this trend which traces its origin back to the time of Eli Whitney.

We all recognize that the studied design of the automobile, as an assembly of interchangeable parts, not only enabled its economical mass production but also made possible the existence of 122 assembly plants in 81 cities of 24 states. A less well-known example of this practice in the industry is given by a firm which builds bodies for the familiar telephone service trucks and other public utilities. This company has switched from custom-building to new simplified designs for standardized production. This design change in turn enabled the company to establish subassembly plants in strategic parts of the country, close to the principal utility customers.

The same principles are applied in other industries; for example, in the furniture industry is found the precision-dimension stock plant, which is located near the source of raw lumber. Working to blueprints and templates, in the same way as the mechanical industries, it turns out chair legs, table tops, and the like, fully machined, holes bored and surface-sanded, and ships them, densely packed, to assembly plants located near the main markets. Shipping costs of either raw lumber or bulky case goods are eliminated. A well-equipped dimension plant in a country location, where there is plenty of land for its lumber yards, drying kilns, and a straight-line single floor layout, may serve a dozen or more city-located assembly plants. Naturally, this kind of manufacture requires that the product be so designed that it can be assembled, without costly fitting and adjusting, from parts made to scaled drawings.

Product design has its effect as well on countless small items. To take just a single one of these: A holding bracket was once

designed as a casting, which meant making it in a foundry with patterns and skilled molders, and the investment that goes with them. Today it is designed to be made from two strips of metal sawed from a standard rolled flat, pierced with a couple of holes and welded on one of the new multipurpose welding machines, all operations that can be performed readily in almost any location. Multiply this one example by thousands of other parts, and their cumulative contribution to dispersion of manufacture is evident.

STANDARD SHOP PRACTICE

The industrial engineer and process planner also have made their contribution to the spread of industry through their codification and standardization of a great mass of information that was formerly available only in the minds of long-time foremen in the traditional industrial centers.

Most metalworking factories today, for example, supplement mechanical drawings and bills of material with standard-process instructions and route sheets, showing for each part the sequence of operations, setup, tooling, time allowed, and so on. Manufacture of a part is transferred readily from parent plant to branch plant by transferring a file of route cards along with the drawings and the tools.

Process engineering is equally advanced in the chemical, textile, food, and other industries, and in all these manufactures we find that many processes have become standardized and common knowledge, although the method in detail may vary from one plant to another.

TECHNICAL TRAINING

Along with the codifying and standardizing of processes has progressed the general dissemination of technical knowledge, both at the level of theories and methods, and at the level of practical mechanical skill.

Technical literature, the universities, and the group activities of some 200 professional societies have done much to make competent staff personnel available to industry in most parts of the country. At the same time, on the practical level, the spread of mechanical knowledge through universal familiarity with the tractor and the motorcar, the extension of state trade-school systems, and the techniques of mass job training in industry, all have had a part in breaking down the walls of the metropolitan labor pools.

REGIONAL RESEARCH

The dissemination of technical knowledge is increased further by the growth of applied research in industry. Some 2400 laboratories today are engaged in industrial research (8). The privately endowed, nonprofit regional research laboratories are the most pertinent to our subject, since they have as their stated aim the increase of the industrial capacity of their respective regions. Two examples of such organizations which have developed and carried to successful manufacture specific regional products are the Midwest Research Laboratories in Kansas City, and the Southwest Research Laboratories in San Antonio. The Pacific Coast and the South offer other examples.

BRANCH-PLANT MANAGEMENT METHODS

Out of the cumulative experience of modern industrial management has evolved a specific body of methods appropriate to the branch plant, giving balance between local responsibility and the necessary final direction in the head office.

The experience of such companies as du Pont de Nemours, with its 85 plants in 20-odd states, General Electric, Sylvania Electric, and Johnson & Johnson, to mention just a few examples, has helped to form the conception of the autonomous plant manager, who is primarily a member of the local community, with civic duties and responsibilities, as well as a delegate of distant management. This was not always the case, and still is not the case everywhere. It took both hard trial-and-error experience, and a great deal of conscious effort to work out this concept of the manager. It is reasonable to say that the man who is appointed to manage a regional branch plant today is a better-rounded more complete executive than was considered necessary or even desirable in the time of his father or grandfather.

In addition to this practice of decentralized management, we have the further fact that knowledge of administrative methods, just like technical knowledge, has become widespread. The methods of production control, storeskeeping, time study, and cost accounting are no longer the special province of the skilled factory executive or the engineer, but have become available to, and understood by, a very substantial proportion of foremen and employees in all industries and in all localities. The extensive teaching and practice of "work simplification" undoubtedly has been a major factor in the spread of this knowledge.

Another factor, and perhaps the most important contribution to branch-plant management, is the idea of working to a plan. It is not our intention here to examine the techniques of forecasts, budgets, market surveys, production schedules, and other forms of planning, but simply to observe that, without the use of these tools of planning, management could hardly have been successful in multiplant operation.

CONCLUSION

In the limited Bibliography given at the end of the paper will be found information pertinent to each of the major factors touched upon in references selected to give a representative sampling rather than for the sake of completeness. It will be appreciated that this paper has been confined largely to elements of industrial management affecting branch-plant expansion and that no attempt has been made to cover the marketing, social, political, and other important phases in the over-all subject of migration or relocation of American industry.

It seems reasonable to predict that the technological and management influences will remain essentially centrifugal and that the profitableness of multiplant operation in a framework of regional manufacturing will continue to grow.

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47 FUNCTIONS *of* DISTRIBUTION

By FENTON B. TURCK

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THE American consumer pays $90 billion a year to cover the cost of distributing manufactured and farm products. This is a staggering amount, but the operation is highly complex and involved.

While these facts are well known, what do we know about the many individual functions performed as a product travels from the factory door to the ultimate consumer? A lack of widespread understanding of the functions of distribution may explain why so little scientific and engineering work is presently applied to this major branch of America's great economic life.

The majority of the functions of distribution are tangible, and when set forth, provide the basis for realistic and constructive appraisal. These functions are listed in outline form in this article and should help to dispel the general impression that distribution is a nebulous operation immune to factual consideration.

FUNCTIONS OF DISTRIBUTION

There are in all 47 functions of distribution. Each of these enters in a minor or major way into the progression of goods from the factory or farm to a paid resting place in the hands of the consumer. The relative importance of any one function will naturally vary among products and industries. So likewise the cost of performing these functions will vary widely and may range from one-half cent of the consumer's dollar to as high as 30 cents.

IMPROVEMENT ASSURED

Constructive analysis of these 47 functions of distribution will assure improvement in the current operations within a company's or industry's distribution system because to date, studies have not disclosed a single company that has achieved a status of perfection in even a major number of these functions.

Pursuing solutions of our distribution problems by measured tread is recommended rather than rushing for answers or seeking the best ways and means through wasteful trial-and-error methods. Distribution problems should be approached objectively and studied by analyzing their component parts. Such a method will produce final conclusions which are sound and which will stand the severest tests.

By breaking up the total distribution operations of a product into its 47 functional elements, it becomes possible to evaluate the cost of each function accurately. Moreover, this step-by-step analysis brings to light the possibilities of improving individual methods used to execute each specific distribution function Also, it will permit comparisons of the cost and effectiveness of each particular function of one company with that of other companies or industries and provide yardsticks against which performance can be measured. Here is a field in which the engineer of tomorrow can make a further major contribution to the advancement of American industry.

An Example: The Function of Discounts and Pricing

As a practical application of the functional approach to our distribution system, let us consider one of these 47 items—the function of discounts and pricing. Pricing and discount systems originally were based on an assumed allocation of function among manufacturers, wholesalers, retailers, and consumers. Many pricing and discount practices established 20 years ago are obsolete because of inherent changes in trade practices of an industry.

Today, we should determine whether a particular wholesaler or retailer actually is performing fewer or more functions than he is compensated for by traditional discount and pricing practices. These changes might affect a number of functions of a financial nature—the assumption of credit risks or of financing retailer or consumer accounts over a long or short period of time. A number of other functions influencing pricing and discount practices relate to packaging, storage, and delivery. These functions are not necessarily performed by the same units in our distribution system today as 20 years ago, when many existing pricing and discount policies were first established.

Payment Based on Services Rendered

It is essential to an improvement of distribution that pricing and discounts be related directly to the actual performance of functions. Currently some wholesalers or retailers are being called upon to perform more functions involving greater expense than they are being paid for, based on traditional pricing habits of the trade. Conversely, there may be many examples of outlets in our distribution systems which are getting paid for functions that they are no longer required to execute.

Trade relations between manufacturer, wholesaler, retailer, and consumer can be placed on a more businesslike basis. This involves a formal contractual statement between buyer and seller, covering not only discounts but also the functions in detail to be performed by each party for each transaction. The present lack of such formalized allocation of functions between manufacturer and distributor is partly to blame for the duplication and, in many instances, deceptive practices in our distribution system.

The function of pricing and discounts in distribution has been reviewed merely to provide one practical illustration of the functional approach to distribution.

STORAGE FUNCTIONS

At first inspection, the three functions of storage may appear to have the same end objective, but in practice this is not the case. Storage by the manufacturer either at the plant warehouse or in field warehouses serves a specific function. Manufacturer's storage represents the flexible coupling of product supply between the continuous plant production line and the requirements of the wholesaler. Products ordered by the wholesaler, usually in large unit shipments, are accumulated in storage units of the manufacturer, frequently for seasonal shipment. These manufacturer storage facilities are now being designed for specific use rather than being provided as just another type of warehouse facility.

In the case of industrial products sold to other manufacturers, this distribution storage facility is becoming increasingly important because high-speed assembly requires a well-organized flow of product from producer to assembler.

The functions of storage by the wholesaler and the manufacturers have different objectives. One of the important operations of a wholesaler is to have on hand a wide variety of items

in one central location to meet the needs of retailer or contractor. Provision of modern wholesaler storage facilities is one of the outstanding recent advances in our distribution system.

The new hardware warehouse of Hibbard, Spencer, and Bartlett in Evanston, Ill., and the pipe and fittings warehouse of Charles F. Guyon, Inc., at Harrison, N. J., demonstrate what can be done to insure low-cost and efficient storage by wholesalers. These modern, well-planned operations for wholesaler storage are certainly a far cry from the general concept of wholesaler storage operations of 20 years ago.

The third storage function performed by the retailer serves the sole requirement of catering to the needs of the consumer. In the sellers' market, the consumer will take a product when and if he is lucky enough to get it. In a buyers' market, or in normal times, the retailer must be able to make spot delivery or at the stated time the consumer requires the product. Storage facilities of the retailer essentially conform to the need of the consumer.

We know by selected examples that, even in these obvious distribution functions, there is an opportunity for thousands of manufacturers, wholesalers, and retailers to do an improved and more effective job. While only a few of the 47 functions have been mentioned by illustration, each function lends itself to analysis, and improvements will result from the intelligent application of scientific methods and modern facilities, to the end that a new source of profit will be revealed.

Service Versus Price

Looking at the price tag of a product certainly does not tell a buyer the whole story of whether he is getting a bargain. If by a markdown of a few cents or a few percentages the seller is able to make the buyer assume the cost of many expensive distribution functions, the buyer has been deceived, unless he is fully aware that he is not getting his full value in distribution services.

Certainly a few cents difference in a price tag may not be full

FUNCTIONS OF DISTRIBUTION

Sales-Department Organization and Administration

1 Manufacturer's co-ordination of sales activity, budget planning, selection and training of salesmen.
2 Wholesaler's co-ordination of sales activity, budget planning, selection and training of salesmen.
3 Retailer's co-ordination of sales activity, budget planning, selection and training of salesmen.

Marketing Research

4 Establishment of market potentials, consumer requirements, sales quotas sales territories, and marketing practices.

Sales Outlets

5 Manufacturer's selection and appointment of distributing outlets.
6 Wholesaler's selection and appointment of retail outlets.

Customer Selection—(single function)

7 Identification and location of potential customers.

Product Design—(single function)

8 For utility and consumer appeal.

Product Testing—(single function)

9 For quality, utility, and market demand.

Pricing—(single function)

10 Manufacturer's cost estimating and price discount quoting to wholesaler, retailer, or consumer.

Advertising

11 Manufacturer's advertising to build consumer demand and distributor confidence.
12 Wholesaler's advertising to promote consumer and retailer interest in both wholesaler and product.
13 Retailer's advertising designed to stimulate consumer to both purchase of product and trade with retailer.

Sales Promotion

14 Manufacturer's sales promotion aimed to increase distributor and consumer interest in the product and the manufacturer.
15 Wholesaler's sales promotion to attract and aid the retailer and consumer.
16 Retailer's sales promotion to build local consumer demand for product.

Selling

17 Manufacturer's sales contact, and closing of sales with wholesaler, retailer, or consumer.
18 Wholesaler's sales contact and closing of sales with retailer or consumer.
19 Retailer's sales contact and closing of sales with consumer.

Credit Investigation

20 Credit investigation by manufacturer of wholesalers, retailers, or customers.
21 Credit investigation by wholesaler of retailer or customer.
22 Retailer's check on consumer for charge accounts.

Financing

23 Financing wholesaler's inventory of finished products.
24 Financing retailer's inventory.
25 Financing consumer time payments.

Accounting

26 Manufacturer's sales cost accounting and budgeting and expense control.
27 Wholesaler's accounting and budgeting plus expense control.
28 Retailer's bookkeeping and budgeting plus expense control.

Billings or Invoicing

29 Manufacturer's billings to wholesaler, retailer, or consumer.
30 Wholesaler's billings to retailer or consumer.
31 Retailer's cash sales and monthly billings to consumer.

Clerical Work

32 Manufacturer's internal control and record keeping.
33 Wholesaler's internal control and record keeping.
34 Retailer's internal control and record keeping.

Packaging

35 Manufacturer's packaging of product for consumer appeal, utility, handling, and storage.
36 Wholesaler's packing of product for handling and storage.
37 Retailer's packaging of product for consumer utility and appeal.

Physical Handling

38 Manufacturer's handling of finished product preparatory to storage or delivery.
39 Wholesaler's handling of product from time of receipt until delivery to retailer or consumer.
40 Retailer's handling of product.

Storage

41 Manufacturer's warehousing of finished product at factory or in field.
42 Wholesaler's warehousing of inventory in field.
43 Retailer's storage.

Transportation

44 Manufacturer's delivery of product to wholesaler, retailer, or consumer.
45 Wholesaler's delivery of product to retailer or consumer.
46 Retailer's delivery of product to consumer.

Product Servicing—(single function)

47 Maintenance, replacement, and repair.

compensation to the consumer for shifting distribution functions from the retailer to the consumer. In many instances, the distribution functions have not been eliminated—they merely have been passed on to the consumer if he has been mesmerized by looking at a small reduction in price.

The production line of industry has become the spearhead of a new American standard of living. Engineers have pointed the detailed way of increasing productivity from the handling of raw materials to the co-ordinated assembly of a complete product.

The 47 distribution functions from the factory door to the consumer are not as easy to visualize as are the functions of an integrated manufacturing operation. Even though distribution functions may be performed under many roofs, many of the 47 functions lend themselves to the application of production-line methods and operations. A "production-line" distribution system is a practical possibility for many companies in the near future.

By presenting a detailed breakdown of distribution into 47 functions, it is hoped that individual manufacturers, as the fountainhead of our distribution system, will initiate practical steps to improve their own distribution operations. The distribution leadership of progressive manfacturers will hasten the application of improved distribution methods by the thousands of wholesalers and retailers and other leading elements in our distribution system concerned with transportation and other distribution services.

UTILIZING THE FUNCTIONAL METHOD

Eight recommendations are advanced in order that this functional method may be utilized to improve the distribution system of a company or an industry.

1 The manufacturer should itemize his distribution operations by functions to the point of sale, i.e., wholesaler or other manufacturer.

2 Itemize additional distribution functions performed from the manufacturer's point of sale to the ultimate consumer.

3 Determine the approximate or actual cost of each function per unit of sales. The total of these individual costs can be verified by comparing it with the over-all difference between actual manufactured costs and price paid by the ultimate purchaser.

4 Review multiple functions, such as transportation, selling, financing, packaging, storage, and physical handling, with the purpose of eliminating unnecessary duplication or triplication of operations by simplification of methods.

5 With the single distribution functions, determine whether present procedures are adequate and in keeping with best present-day practices. This recommendation applies to five of the 47 functions.

6 Manufacturers should also consider their distribution policies in the light of actual and potential ultimate markets and not solely from the standpoint of their immediate sales outlet.

7 Develop a formal allocation of distribution functions between manufacturer and wholesaler or retailer. A restatement of the detailed functions to be performed by each party will avoid duplication of effort and strengthen basic trade relations.

8 New products—the various distribution functions required for distribution to different markets should be itemized. The purpose of this study is to establish the most desirable low-cost distribution system for the new product. The expensive trial-and-error search for a new product market is no longer necessary if this functional approach to distribution is followed.

DISTRIBUTION OFTEN A BLIND SPOT

The full importance of distribution is not generally appreciated, even within companies whose very existence depends on the continuous loyalty of its customers. It may seem difficult to accept the fact that distribution, a dynamic $90 billion part of the American economy, is today a blind spot to the managements of many industrial companies and is frequently ignored by leading economists. Today only a handful of companies have a head of distribution in their management family. Companies generally have a sales manager with responsibilities restricted to a limited number of their total distribution functions.

If this general oversight of total distribution operations has been due to a lack of a sound basis for coping with company distribution problems, we can now look to the future with practical optimism. The full scope of distribution is a broad horizon. However, at least we have a three-legged stool to stand on. Distribution has been (1) defined, (2) measured, and (3) separated into its 47 component elements.

The author's definition of distribution was adopted by the Management Division of the Society in 1944, as follows:

"Distribution is the total of all activities involved in the progression of goods from the producer to the consumer. It includes warehousing, transportation, wholesale and retail marketing, advertising, and a substantial part of research, engineering, accounting, and financing."

The basis of measuring distribution was presented before the Marketing Conference of the Chamber of Commerce of the United States, March 11, 1947, as follows:

"To achieve a necessary and desirable increase of distribution power, management should apply to all functions of distribution the same standard which, for years, it has been applying to all functions of production—the standard of productivity per man-hour. We know that this standard works. It is responsible for America's great strides in production over the past thirty years. By the standard of productivity, it was possible to place exact valuation upon all existing production procedures and to appraise the merits of proposed improvements. This applied whether the improvement was represented by a complex machine or by a simple conveyer belt. I believe that application of the standard of productivity—function by function, department by department—can do for distribution the same thing that it did for production."

Finally, the breakdown of distribution into 47 functions is itemized in this article.

We now have a practical way for a company to tackle its distribution problems. This functional approach to distribution can serve the practical purpose of giving individual companies a step-by-step procedure to improve their distribution operations. Following the eight recommendations offers a double reward to alert management—profits from new customers and markets, as well as reduced consumer prices. The result of these improvements in distribution by individual company efforts collectively will add large benefits to our total economy. Action by the individual company is the key to a total improvement in our distribution system.

We know the over-all scope of distribution. We know how to measure operations, and, finally, we know the primary elements of distribution.

The further advancement of our distribution system promises a new and vital economic outlook based on continued scientific research and widespread application of proved engineering procedure. This action by industry would assure the continued advancement and stability of production and would build increased purchasing power for all Americans.

APPRENTICESHIPS *in* MANUFACTURING MANAGEMENT

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A DISTINGUISHED educator recently summarized his viewpoint toward the educational process:

"Effective education may be described as a man and a boy, walking along a road, talking together in a friendly atmosphere."

This peculiarly personal nature of successful education has long been recognized by the authors' company. It has been emphasized in its long-established "sales training program," as well as in its "advanced engineering program" (1)[1] and the "creative engineering program," which has been previously described (2).

In the field of training for manufacturing management, experience has indicated that effective educational programs must be established on a personal basis. Leadership skills have been developed most readily by those men who have had the good fortune in their careers to work under the guidance of seasoned successful managers of men.

This situation is recognized by the Apparatus Department of the company in its "manufacturing leadership program." The core of this pattern of planned leadership development is the "personal apprenticeship" of young men, selected for their administrative potential, to experienced manufacturing executives.

The program also includes training of the young men in modern manufacturing techniques, and their rotation among several different manufacturing responsibilities. An over-all conception of the entire scope of product manufacturing is fostered, since men are being developed for major manufacturing positions.

Apparatus Manufacturing has recognized in its program the wide variety of managerial "styles" among executives. Two equally successful administrators may vary widely in their individual personalities, backgrounds, and interests. So the manufacturing leadership program, or "management apprenticeships," as it is frequently called, is tailored to fit the individual needs of trainees. Standardization of assignments is carefully avoided. Trainees participate directly in the formulation of their training schedule and assignments.

Organization of the program is based on the fact that the most effective point at which management development can take place is between a trainee and the experienced executive who is his superior. Training is an important part of the function of the line organization, and the primary training job is carried on by the line. Staff activity in management training is to assist the line in carrying on this program, to co-ordinate the program, and to stimulate an awareness of the importance of this training at all levels of manufacturing management.

GENERAL OUTLINE OF MANAGEMENT APPRENTICESHIPS

A young man selected for the manufacturing leadership program has three opportunities open to him: He may be trained in general manufacturing, in production control, or in methods, planning, and wage rate. Whichever of these options he chooses, the young man will enter a program of training which concentrates upon his personal development as an individual, rather than upon his indoctrination in narrow trade skills.

This personal development is gained by assigning the trainee a series of increasingly important manufacturing responsibilities; it is gained by the expression of his ideas at many conferences and group meetings; it is gained by his being counseled periodically by experienced managers. Classroom courses are used as one of the means for making information available to the trainee; but classroom courses are merely a part of the program for developing manufacturing leadership; they are not the whole program.

The manufacturing leadership program has two definite steps. The chart in Fig. 1 illustrates these steps in the three options available. Step 1 involves broad training which concentrates upon the trainees' learning manufacturing fundamentals at one of the company's works or plants. All management apprentices go through Step 1. Men who perform satisfactorily during this training are assigned to responsible posts in manufacturing management.

Those who have shown unusual potential for manufacturing leadership, and who have demonstrated that they will benefit from additional training, are selected for Step 2 of management apprenticeships. This training concentrates upon rotation among two or three plants of the company. The trainee is made responsible for several important manufacturing management projects during this phase of his training.

ADMINISTRATIVE FUNDAMENTALS OF THE PROGRAM

It may be of interest to review some of the administrative fundamentals associated with the management apprenticeship program.

Personnel Audit. The proper number of men to be chosen for this program is determined most effectively by a "personnel audit." This audit simmers down to an analysis of the next several years' requirements for men to fill manufacturing management posts created by retirements, promotions, and expansion.

When this number of men has been decided upon, the total number is translated into yearly quotas. These quotas are then used as the basis for the selection of trainees.

Selection. Selection of men to fill these quotas is based upon several factors. The record of the men in their previous work with the company, such as the test program, is carefully analyzed to determine their potential for leadership. Men who seem to have the proper potential are recommended from both the line and the staff organizations. They are then interviewed individually by a number of responsible supervisors representing varied manufacturing activities.

A series of psychological tests also may be used to throw additional light upon the potentialities of these men. These

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

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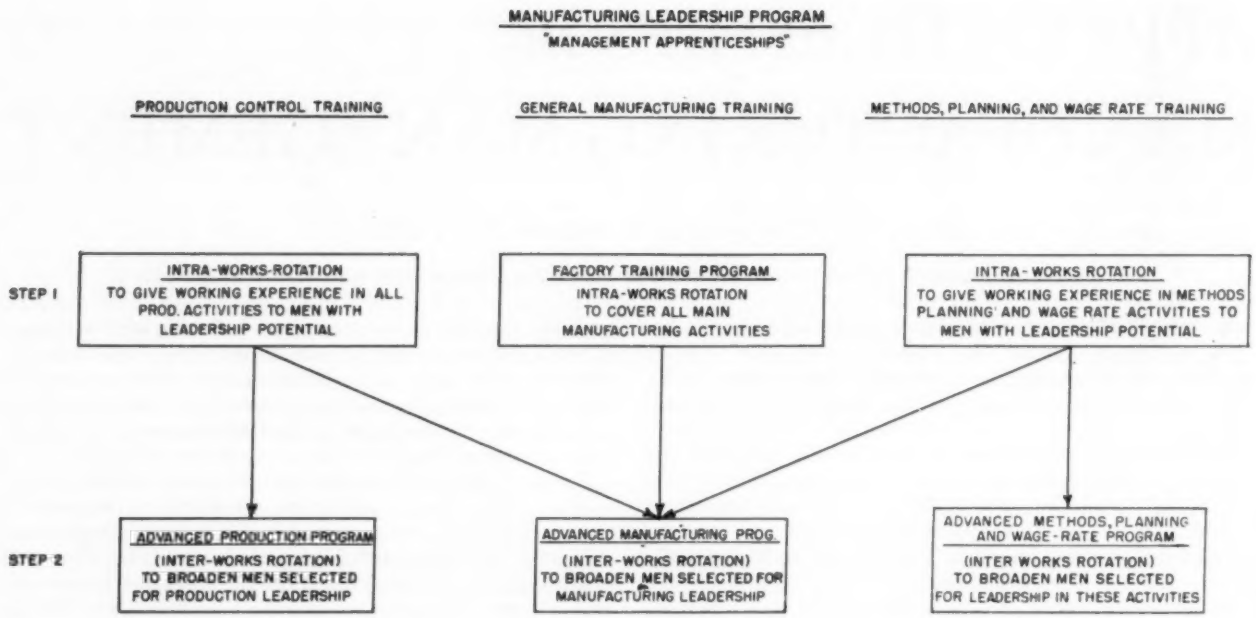
MANUFACTURING LEADERSHIP PROGRAM
"MANAGEMENT APPRENTICESHIPS"
PRODUCTION CONTROL TRAINING
GENERAL MANUFACTURING TRAINING
METHODS, PLANNING, AND WAGE RATE TRAINING
STEP 1
INTRA-WORKS-ROTATION
TO GIVE WORKING EXPERIENCE IN ALL PROD. ACTIVITIES TO MEN WITH LEADERSHIP POTENTIAL
FACTORY TRAINING PROGRAM
INTRA-WORKS ROTATION
TO COVER ALL MAIN MANUFACTURING ACTIVITIES
INTRA-WORKS ROTATION
TO GIVE WORKING EXPERIENCE IN METHODS PLANNING AND WAGE RATE ACTIVITIES TO MEN WITH LEADERSHIP POTENTIAL
STEP 2
ADVANCED PRODUCTION PROGRAM
(INTER-WORKS ROTATION)
TO BROADEN MEN SELECTED FOR PRODUCTION LEADERSHIP
ADVANCED MANUFACTURING PROG.
(INTER-WORKS ROTATION)
TO BROADEN MEN SELECTED FOR MANUFACTURING LEADERSHIP
ADVANCED METHODS, PLANNING AND WAGE-RATE PROGRAM
(INTER WORKS ROTATION)
TO BROADEN MEN SELECTED FOR LEADERSHIP IN THESE ACTIVITIES

FIG. 1

tests include those for intelligence, judgment, and vocational preference. They include such projective techniques as Rorschach "ink blots," and a form of the thematic apperception test to assay leadership qualities (3).

From his record, his interview results, and his tests, a comprehensive measure is available of a man's possible potential for administration. Selection for management apprenticeships is based on an appraisal of these several factors.

Sources of Trainees. Graduates of engineering colleges are among those eligible for the manufacturing leadership program. These men are usually drawn from the company's test engineer program, rather than being hired directly from college. Graduates of the company's business training course, designed for business administration and liberal arts college graduates, are considered for the program. Also eligible are apprentice graduates, competent young shop employees, and any others who have potential. The manufacturing organization is surveyed continually for promising young men who show administrative possibilities.

The test program is the normal channel of entry into the company for engineering graduates. These graduates may have assignments ranging from the actual testing of technical apparatus to work in such manufacturing functions as time study, production and quality control.

Test introduces the engineering graduates to the company and acquaints them with its products. It allows them to survey the whole broad field of opportunity before committing themselves to a specialized kind of work. It enables the company to measure their abilities and to judge their personalities. It furnishes qualified men with supervisory experience.

At the completion of this test engineer training, the engineering graduate chooses his assignment from the opportunities which are open. He may enter fields such as product engineering and sales, or he may join the manufacturing leadership program.

TYPICAL MANAGEMENT APPRENTICESHIP PROGRAM

The operation of the management apprenticeship program may be illustrated by a review of training for men who select the general manufacturing option.

These men first join the factory training program at one of the major company plants. This program is designed to give the trainee the benefit of acquaintance with such essential manufacturing activities as production control, labor relations, factory supervision, wage-rate administration, methods and equipment planning, personnel administration, cost accounting, cost reduction, and quality control.

Assignments range from the actual operation of machine tools at the start of the training program, through various line, staff, and functional activities. The trainee is always assigned definite responsibilities which he discharges under the guidance of an experienced manufacturing supervisor. Trainees may be assigned such responsible posts as factory foreman, assistant production supervisor, or assistant methods supervisor.

Assignments are tailor-made to the needs of each trainee. As they develop in background, trainees begin an "upward spiral" of these assignments, each one entailing more and more responsibility. Every man is followed closely on the basis of assignment sheets similar to that shown in the chart, Fig. 2. All trainees will not, of course, require every assignment shown on this chart.

The factory training program includes a series of group meetings at which trainees meet company executives and enter discussions with them. Some classroom work is required of all students.

Men who show unusual aptitudes for manufacturing management during their factory-training assignments may be chosen for the advanced manufacturing program. Members of this program concentrate upon special projects in the field of manufacturing management. Emphasis is placed upon manufacturing fundamentals, and classroom work is available to these men in the Apparatus Department's advanced manufacturing management classes. These classes cover such fields as industrial economics, organization planning and administrative practices, labor relations, production and inventory control, and wage-rate administration.

Recommended reading assignments and case studies are given out for analysis at periodic group meetings held at various plant locations. Advanced manufacturing program trainees spend the duration of their training time, which is approxi-

ASSIGNMENT SHEET FOR

DOE, JOHN E.

LINE ASSIGNMENT	COMPLETED	STAFF ASSIGNMENT	COMPLETED
MACHINE WORK	X	GENERAL ACCOUNTING	
PRODUCTION CONTROL		GENERAL COST	
PURCHASING		LABOR RELATIONS	X
COST		PERSONNEL	
PLANNING AND METHODS	X	WAGE RATE ADMINISTRATION	X
SPECIAL ASSIGNMENTS	X	MFG. LOSSES & COST REDUCTION	
FOREMAN	X	QUALITY CONTROL	X
FUNCTIONAL SUPERVISOR		PLANT REARRANGEMENT	
GENERAL FOREMAN		SAFETY	
ASS'T TO SUPERINTENDENT	X	MANAGER'S OFFICE	X

AVAILABLE FOR NEXT ASSIGNMENT JUNE 1949

NOTE: X-ASSIGNMENTS MEN HAVE HAD

FIG. 2

mately 18 months, at two or three major apparatus plants.

An analogous sequence of training takes place in both the production control and the methods, planning, and wage-rate options. While the details of training in these fields differ somewhat from that in general manufacturing, the same basic fundamentals apply.

Men in any of these three options of the manufacturing leadership program are eligible for positions of responsibility in manufacturing management. The nature of their training and the program of personal development which has been associated with this training enable them to make important contributions, both to their own careers and to the manufacturing activities of the company. At the conclusion of the formal phase of the manufacturing leadership program, a broadening experience program continues to the extent justified by an individual's capacity for further advancement in the organization.

TRAINING FUNDAMENTALS OF THE PROGRAM

Also of interest in an analysis of Apparatus Department management apprenticeships are some of the training fundamentals involved.

Participation. Great emphasis is placed on the active participation by the trainee in the many decisions which affect him. Trainees have an important voice in the selection of their assignments. It is they who organize the group meetings held at the various apparatus plant locations. It is they who conduct the advanced manufacturing management classes, and rotate as chairmen for these classes (4). It is they who lead the frequent case studies, and carry on the role-playing activities which are often part of group meetings and classes (5).

Personal Development. Particular emphasis is placed upon the development of friendly relationships between the trainees, the line executives, and the training staff, and among the trainees themselves.

The practice of counseling is closely followed (6). Trainees have periodic "bull sessions" with members of the training staff. They discuss their progress in the organization; those features of their job performance which might be improved are brought out for their comments and judgment.

Responsibility. The apprenticeship type of training is most effective when the trainee is delegated actual responsibilities during his assignments. At each stage in his "upward training spiral" the trainee gets much practice in acting under responsibility for the consequences of his actions. This is accomplished most effectively through "learning by doing," rather than by looking over shoulders (7). Trainees are assigned to supervisory posts as quickly as possible further to achieve this objective.

Training Men With a Wide Variety of Backgrounds. An important selection fundamental in the manufacturing leadership program is that administrative potential is to be found in men with widely varying backgrounds. Experience shows that successful managers have been graduates of the long-established company apprentice program; men who have come through the shops; liberal-arts and business-administration college graduates who have gone through the company's business-training course; and, of course, engineering graduates who have completed the company's test engineer program.

As a result, the door to management apprenticeships is open to men with any of these backgrounds.

This selection policy makes it necessary to establish a tailor-made training schedule to fit the particular needs of each individual within the broad framework of the program's objectives. Classroom training in manufacturing fundamentals, for example, is carried on in such a fashion that it is geared to the different backgrounds which trainees may bring to the manufacturing leadership program.

Training by the Line. The actual job of training management apprentices is carried on by the Apparatus Department's line organization. Experience has shown that it is through the face-to-face contact of immediate supervisor and trainee that the most effective development of leadership can take place.

A manufacturing training staff is available for assisting the line organization. This staff also co-ordinates the interworks rotation phase of the manufacturing leadership program. The objectives of the training staff may be simply summarized as follows:

1 To aid the line in carrying on leadership training.
2 To stimulate an awareness of the importance of training at all levels of manufacturing management.
3 To co-ordinate those programs which are department-wide in their scope.

Development of Sound Business Judgment. Rotation among a series of functions provides a knowledge of the related nature of all manufacturing activities. Specialization is avoided during the training period, not because specialization is necessarily detrimental, but because the vision of the whole manufacturing problem is so vital to men who are being trained for managerial roles. In essence, the management apprenticeship program is education rather than vocational training.

With responsible assignments and guidance, the trainee soon comes to realize that a great variety of imponderables enter into business decisions. When buttressed by classroom work which stresses the human aspect of business problems (8), an approach is made to breaking down the habit of confining one's decisions solely to deductive thinking, which takes many intangibles for granted, or which ignores them. Instead, training is provided in reaching decisions based upon every factor, both certain and uncertain, which affect a problem (9). Experience seems to show that this combined deductive-inductive approach is essential to successful administration.

Postprogram Training. Men continue to be broadened after they have been given a management post at the conclusion of their formal training. Company courses such as better business management, the nine-point job, and economics are concerned primarily with fundamental problems affecting management of a business rather than with specialized problems on any particular phase of operations. In addition, men continue to move among various functions horizontally as long as it appears

that they can continue to move vertically in the organization. In short, they continue to receive an education rather than a purely vocational training.

CONCLUSION

The objectives of the manufacturing leadership program, that has been described, may be briefly summarized:

1 To supply an adequate pool of satisfactorily qualified and seasoned individuals to fill key manufacturing management positions throughout the Apparatus Department.

2 To insure that complete opportunity is afforded to appraise and to develop the full administrative potential of these promising individuals.

3 To stimulate an awareness of the importance of this sort of training—with its complementary obligations of selection, appraisal, and placement—throughout all levels of manufacturing management.

These objectives are met by:

1 Selection of adequate numbers of young men, with administrative potential, for training as management apprentices.

2 Development of the full capabilities of each trainee through "personal apprenticeships" in a succession of well-selected and increasingly responsible assignments, supported by classroom work, periodic counseling, and other means to aid the trainee to realize his full potential.

3 Placement of these competent young men in responsible manufacturing management posts upon the completion of the program; and continuation, on a less formal basis, of their broadening after this placement.

Management apprenticeships, effectively operated, represent an effort to produce trained minds and administrative personalities. This type of development program welds together familiarity with facts, and the process of logical reasoning—so characteristic of engineering training—with ability to take intangibles into account. It involves a systematic view of things as a whole, rather than complete concentration upon the parts of the whole.

All of these abilities are necessary in order to cope successfully with the problems of administering a complex manufacturing organization. To the extent that a capable young man is not equipped with these fundamentals, industry has the problem of supplying them if it is to overcome its most serious shortage, namely, that of managerial skills. Management apprenticeships offer an effective approach to the solution of this problem.

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7 Of interest in this connection is John Dewey's point that if theory is taught separate from practice, it is almost impossible to expect the student to apply the theory to practical problems. If the fundamentals are taught in the first place by practical men in relation to practical problems, the student automatically learns to apply the theory. See: "How We Think," by John Dewey, D. C. Heath, Boston, Mass., 1933, p. 52–53.

8 Trainees complement their other reading with such material as "Conditions of Effective Leadership in the Industrial Organization," by Douglas MacGregor, *Advanced Management*, Oct-Dec., 1944.

"Human Relations in Industry," by Burleigh Gardner, Richard Irwin, Chicago, Ill., 1945.

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9 For a further discussion of this issue see "Organization and Management," by Chester I. Barnard, Harvard, 1948, chapt. 8.

Heating and Ventilating of the Martin 202 Airliner

(*Continued from page 648*)

position, all of the automatic temperature controls are by-passed, and the heater will operate continuously, except when interrupted by the cycling or overheat thermal switches. The low-heat and heater-purge switches, and the ram-pressure and fuel-pressure switches remain effective in both manual and automatic operation.

Appropriate ducts are provided so that, by manual control of dampers in the event of a complete heater failure, heated air from the wing anti-icing system may be diverted to the cabin heating system. In this case the amount of cold air entering through the cabin heating and ventilating scoop and mixing with the heated air from the wing anti-icing system may be controlled from the copilot's station. When this is necessary, the stewardess' selector switch is placed in the off position, thus by-passing the normal positioning circuits, and allowing the position of the main intake damper to be controlled from the copilot's position by means of a manually operated rheostat located just outboard of the seat. The by-pass damper is controlled manually from a push-pull control located behind the seat, and actuates a single-pole double-throw switch which operates the booster fan.

An emergency shutoff switch on the cockpit overheat electrical panel can be used to shut the heater off in an emergency. This switch is in the on position at all times, except when there is an indication of fire in the heater compartment. In the off position, this switch shuts off the fuel and ignition to the cabin heater and completes the fire-extinguisher circuit for the cabin heater compartment, permitting discharge of the extinguishing agent through a separate operation.

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Implications of FOREIGN SERVICE *in the* ENGINEERING WORLD

By LAURENCE DUGGAN

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HAVING returned from Europe only a few months ago, there are still many times in the day's activities when events seem strongly related to recent experiences abroad.

In contemplating the vast wealth of scientific data being disseminated through organizations such as this Society, my thought goes back to discussions with doctors, teachers, and engineers in Brussels, Paris, and Amsterdam. What they said essentially was "we need to catch up." As can be imagined, they were referring to the intellectual isolation of almost ten years' duration—a decade of being shut off from the stimulating process which is going on in this country continually—the interplay of ideas, the sharing of new directions, the broadening of scientific horizons.

I can imagine the ecstasy of some of my scientific friends in Europe were it possible for them to partake of the feast of technical information available here on almost every conceivable subject upon which ceaseless studies are being made. To those who hunger for knowledge, there is no question but that we are guests at a banquet table. Believe me, this is no mere play on words to speak about the intellectual hunger of Europe and Asia. It is as real as the pangs of bodily hunger.

By the thousands, men and women in technical fields abroad again wish to gather up the threads of intellectual association which were so valuable to them before the second world war. They need it for their own personal cultivation, and they also see the appalling physical needs of their countries against which their increased skill can be applied. These leaders in foreign lands know that the ravages and debts of war cannot be lifted by any magical stroke of government action. They know that improved conditions in their lands will come only by generations of hard work and applied skills. If one thinks for a moment of the large debt settled upon the United States by four years of total war, and then considers that China, as simply one country, for example, has been continually at war since July, 1937, eleven unproductive years, he can see that the struggle there in the years ahead will not be solely political, but that there is a gigantic engineering problem involving hydroelectric plants, building of schools, roads, public buildings, homes, and the satisfaction of a myriad other needs.

Responsible leaders within all these countries which are underdeveloped or war-ravaged know that sooner or later minimum physical needs of their people will have to be met. They know also that this cannot be accomplished alone by importing vast millions of dollars worth of materials from the United States under the Marshall Plan or other aid plans. They realize full well that their own initiative is the thing which for the years ahead will spell successful recovery and development. To this end, then, there is a high premium on technical and productive know-how. The engineer is king. His abilities to plan, to perfect, and to produce are invaluable to most of these distressed areas.

There are two ways in which the United States can render this engineering aid to these foreign areas. One is by bringing selected technical personnel to this country for advanced study. Another is by sending American engineers abroad for special services.

Though much of the time of our Institute of International Education is devoted to the first, namely, facilitating the advanced study by foreign engineers in the United States, I would like to remark about the responsibilities and opportunites of the American engineer abroad.

As I have pointed out briefly, each one of our American engineers who goes abroad is a pearl of great price, whether he goes to cope with the rebuilding of cities in Europe, or the development of untapped resources in Africa and Asia, or to help in the improvement of production methods in South America.

Each American who goes abroad to live for any period of time, however, goes to a nation with different cultural, ethical, and business traditions from our own. As an actor in a traveling stock company, he plays many roles. I should like to discuss with you the five distinct functions which I see each engineer performing at some time in his foreign work.

THE ROLE OF THE ENGINEER IN FOREIGN LANDS

Primarily, he is a technician. It is because of his superior technical knowledge and his ability to use that knowledge to achieve results that his services are employed. He is sought for his ability to apply knowledge as much as for that knowledge itself. In this respect the American engineer has a considerable advantage over fellow engineers drawn from a feudal agricultural society where cheaper labor has retarded the introduction of machinery. The American boy is brought up to tinker, to repair things around the house, to keep the old jallopy running. He learns how to use his hands, how to improvise, how to handle machinery, and unconsciously he also learns the dignity of manual labor.

Most foreign engineers from feudalistic agrarian societies are sons of the well-to-do. They do not have to tinker because there are servants aplenty to do that. They have a snootiness about manual labor which they have difficulty in overcoming. Many of these foreign engineers would do better in the pure sciences, for instance, mathematics or physics, where success is measured by intellectual output, rather than in engineering, where success is measured by visible results. Many American engineers abroad have been disconcerted by what appeared to them to be the superficial and impractical approach of local engineers. This is not always fair. A quick judgment of others without consideration of the culture which bred them can often result in a half-truth. Broad tolerance and understanding is called for.

This brings me to my second point. The engineer is also something of a social scientist. The fact that he is in a different cultural environment from his own and that he possesses knowledge and managerial skills not possessed locally may set up the framework of a superiority-inferiority relationship. Most American engineers are sufficiently well rounded not to "throw

[1] Deceased, December 20, 1948.

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their weight around" abroad. But it does happen. I saw it during the war in Central America in connection with the building of the Inter-American Highway. What is much more probable is that the American engineer, without knowing it, may foster certain attitudes of inferiority with those with whom he comes in contact. The breezy, self-confident manner in which Americans go about the business of "getting things done" may often appall less self-contained peoples. The confusion of people in underdeveloped countries when confronted with mechanical problems, their dislike of social change, their strong sense of values inherent in their customary institutions, should suggest to the American engineer that he be especially tolerant of slow acceptance and understanding of new techniques.

How, for example, would any of us feel if foreigners were called in to plan, execute, and manage the most important of our town's industries and public works, and particularly if these foreigners took on an air of condescension toward us, as though we were not quite civilized? It is hard for us to imagine ourselves in this situation, but a moment's reflection suggests the emotions we might feel and the hostility we might develop, not only toward the foreign engineers but also against the country from which these engineers came. In addition to developing a sensitivity to another culture, the engineer as a social scientist will make out better if he studies in advance this new culture through its history, language, and economy. Then, equipped with a good basic grounding in the area's institutions, able to speak its language, and prepared to be friendly, the American engineer should be able to avoid the resentment sometimes directed toward foreigners in these positions.

This leads to my next point. The engineer is a cultural emissary, whether he knows it or not. Every American abroad is regarded as a typical example of all Americans. American tourists abroad leave a fleeting impression, and frequently not a very good one. Too often they may be like the American businessman who was asked how he liked Paris. "Oh, Paris is a great place," he said. "The only trouble with it is that there are too many foreigners there." Popular opinion overseas frequently marks us down as a people leading rather thin superficial lives, engrossed with making money, enjoying cheap music, going to baseball games, chewing gum, and attending our bad Hollywood movies. The American who lives and works for some time in a foreign land has a chance to correct many of these impressions and reflect our more praiseworthy traditions and values. If every American about to go abroad could be made to understand this, the view of the United States by some foreign countries might be different.

Those Americans who have sought out foreign friendships, who have been welcomed into the social and cultural life, have felt themselves richly rewarded. They not only have a broader concept of the local setting, but they find this understanding helps them to get their work done. They may be aware, of course, that association with the local population—popularly termed "going native"—is sometimes held up to ridicule. Such comments usually come, however, from unimaginative Americans who limit their social and intellectual life to the English-speaking community, thereby immersing themselves in a small imported world and losing the stimulation and inspiration which come from relationships with people of different outlook.

WE MUST SHARE OUR KNOWLEDGE

Then the engineer is also a teacher. In the degree to which he passes along his applied skills to his co-workers so that they in turn may teach others, he performs the age-old process of on-the-job training. If we can share our basic knowledge with less fortunate countries, we not only will be helping them, but we will be helping ourselves and our own engineering profession too. As South American countries, for example, improve their standard of living by increasing their productivity with the assistance of American engineers, there will be more and more calls upon us for new assistance instead of less and less. These areas will want increasingly to develop their agriculture, mines, and industries.

This sort of situation is on all fours with the export of American machinery which will make it possible for foreign areas to manufacture what previously they had imported from the United States. We all know that with the rise of living standards trade increases, not decreases. Great Britain, for instance, has always been our best customer. And so it is in the export of technology which is part of the whole process of helping other lands improve their living standards. The training of foreign engineers—whether in their own lands, or here, for that matter—will help all concerned to enjoy a better life.

MUCH TO BE LEARNED ABROAD

In addition to teaching, there is much to be learned abroad. I am not talking here about acquiring a general knowledge about foreign lands. Enough has been said to indicate opportunities for that. I refer to the possibilities of picking up practical engineering information that will help our engineers to do a better job. This is especially true in such countries as England and Switzerland, where in certain fields special techniques have been highly developed over a long period of time. Not many American engineers are likely to be invited to work professionally in such countries, but on vacations or en route to other jobs they might visit these countries and meet and listen to those specialists from whom Americans can learn. In this connection, it is interesting to observe that certain countries are following the lead of Australia, which, during the war, appointed a scientific attaché to its embassies in Washington and London, and has since made these appointments permanent.

But American engineers can also learn in less developed countries. For instance, take skyscraper construction out of steel rods. During the war, when structural beams were unobtainable because of war construction in this country, many a high building was put up in Mexico City and in Rio de Janeiro with steel rods instead of steel beams. More than one American engineer has told me that we could learn a lot from this type of construction.

My guess would be that, because of the absence of many materials and conditions generally regarded as necessary at home, foreign engineering jobs would require a maximum of resourcefulness and inventiveness, and would impel the engineer to improvise techniques which might make a real contribution to the profession as a whole.

These, then, are the five roles of the engineer—technician, social scientist, cultural representative, teacher, and student. There may be others, such as diplomat, but these, I think, are the most important.

The quality which will assist him most is patience—the realization that human progress is not swift and that the tempo of life varies with differing cultural groups, climates, and social forms. He will not then expect the same performance from a worker whose background, education, diet, and living conditions are inferior to that of the American worker.

An engineering job in a foreign land is a challenge—a challenge not only to the engineer's skill and training, but also to himself as a personality, as a representative of his profession, and as a representative of our democracy—the target today of respect and condemnation, of admiration and abuse.

1949 EMPLOYMENT PROGRAMS *for* ENGINEERING GRADUATES[1]

INTRODUCTION

THE General Survey Committee of the Engineers Joint Council has recently conducted a spot survey of industrial companies and governmental agencies concerning their 1949 employment programs for engineering graduates. This committee was set up last summer by the Council, which is made up of representatives of the major engineering societies, to act as a central fact-gathering agency to secure reliable information concerning significant trends within the engineering profession. A supplemental purpose is to diminish the need for independent surveys in this field.

The questionnaire, prepared for use in this first survey undertaken by the committee, was sent late in January, to about 500 carefully selected industrial and governmental organizations. Of the 198 returns included in this report, the great majority were received between February 15 and March 15, and represent the situation as of that time. This final report shows no major changes in the findings of a preliminary one sent to the responding companies and the deans of the engineering schools late in April.

The survey sought to cover the following points:

1 The relative demand for inexperienced engineering graduates in 1948 and 1949.

2 The 1949 starting salaries for such graduates with bachelors', masters', or doctors' degrees, together with related information on differentials by curricula or geographical area, credits for military service, and increases during the first year of employment.

3 The trend of salaries for engineering graduates 10 years out of college since the 1946 survey of the Engineers Joint Council, reported in the volume "The Engineer in Transition," as merely an indication of the salary trend for such graduates of some maturity.

To assist in evaluating the data secured, related information concerning the total number of employees in the organization, and the number of engineering graduates was also requested.

SUMMARY OF THE FINDINGS

Excluding a few organizations providing fragmentary information, data have been tabulated for 162 industrial companies and 31 governmental agencies with over 4,000,000 employees, of whom almost 90,000 were engineering graduates, or about one third of an estimated 265,000 such graduates in the country.

These organizations reported that they had hired 10,400 inexperienced engineering graduates in 1948, and estimated that they would hire 8175, or some 21 per cent less in 1949. For the ndustrial companies, the decrease was 26 per cent to a total of 5700; for the governmental agencies, 9 per cent to one of 2480. Agencies of the state governments actually expected a substantial increase. The estimated employment includes 1066 chemical or ceramic engineers, 1950 civil or structural, 1960 electrical, 2760 mechanical, aeronautical, or industrial, 190 mining, and the remainder scattering.

On the basis of the starting rates reported, 25 per cent of these men at the bachelor's level would receive a starting rate of $275 per month or more, 50 per cent one of $255 or more (the so-called median rate) and 75 per cent one of $250 or more. For those employed by concerns seeking mainly chemical or ceramic engineers, the median bachelor's rate was $290; for those seeking mechanical, aeronautical or industrial, engineers, it was $265; and for those seeking civil, electrical, or other engineers it was $250.

The median rates reported by organizations, without regard to the numbers of men to be employed, was likewise $255 for bachelors, $300 for masters, and $375 for doctors. The highest median rates for masters ($310) and doctors ($400) were also offered by organizations seeking principally chemical or ceramic engineers.

A median monthly increase of $30 is given by the end of the first year by the organizations in this group; 45 per cent of them give this total at one time, 49 per cent in two installments, and the remainder in three or four installments.

Only 91 organizations provided data concerning the salaries of engineering graduates 10 years beyond their bachelors' degrees late in 1946, and 10 years out late in 1948, and, to some extent, these data represented estimates rather than exact figures. For 1747 graduates 10 years out in 1946, the median monthly salary was $380 and for 1718 who were 10 years out in 1948 it was $440, or 16 per cent more. The 1946 figure corresponds closely with that secured by Engineers Joint Council survey of individual engineering-society members at that time, and on that basis the new data for both years may be regarded as reasonably reliable.

RELATIVE 1948 AND 1949 DEMAND

Table 1 presents information on total employees and engineering-graduate employees in the organizations responding by industrial and governmental groups, together with their 1948, and estimated 1949, employment of such graduates.

Although the organizations, represented in Table 1, include less than one seventh of the total employees in the manufacturing, mining, construction, public-utility and transportation industries and in governmental agencies, they have about one third of an estimated 265,000 engineering graduates in the country. Even though the 10,400 inexperienced graduates they employed in 1948, presumably included some men who were graduated before that year, they represent a somewhat similar proportion of such graduates who then became available for employment. Although these organizations obviously represent a widely varying proportion of their industries, it may be concluded that they constitute a significant and reasonably reliable sample of the total employment market for the e graduates. While the decreased demand indicated for 1949, undoubtedly has been influenced by the recent decline in bus ness activity, it is probable that the filling of shortages accumulated during and immediately after the war has been a large factor.

In most instances the governmental agencies covered are those of a technical character and for that reason as well as others, the relation between total and engineering employment

[1] Report of the General Survey Committee of the Engineers Joint Council, M. M. Boring (ASEE), Chairman; Donald S. Bridgman (AIEE), Secretary; E. L. Chandler (ASCE), L. E. Young (AIME), A. C. Monteith (ASME), W. T. Nichols (AIChE), and W. H. Larkin (NSPE), Members. Presented at a meeting of the Council held in New York, N. Y., May 9, 1949.

TABLE 1 EMPLOYMENT OF ENGINEERING GRADUATES BY INDUSTRIAL AND GOVERNMENTAL GROUPS

Employing organizations	No. org.	Total employees	Engineering graduates: Total in organization	Inexperienced: Hired 1948	Inexperienced: Quotas 1949	Change per cent
Industrial:						
Aircraft	4	53500	1850	345	115	—66.5
Automotive	6	602200	3495	393	445	+11.3
Building materials	8	24948	1278	141	92	—34.7
Chemical	12	159575	6580	544	496	— 8.8
Consulting	4	3631	692	58	31	—46.5
Construction	4	18967	1486	88	52	—40.9
Electrical	8	429396	18189	2101	1376	—34.5
Food	9	120501	697	72	76	+ 5.3
Glass	3	29700	451	36	39	+ 8.3
Instruments	8	25016	1413	152	96	—36.6
Machinery	20	236726	3470	355	332	— 6.5
Metals	16	285837	4384	642	565	—12.0
Paper	7	28278	404	86	67	—24.4
Petroleum	10	195453	5152	969	627	—35.3
Public utility	24	696764	10864	996	669	—32.8
Rubber	6	183730	3620	404	303	—25.0
Shipbuilding	2	5000	50	5	17	[a]
Soap	2	20500	870	156	151	— 3.2
Textiles	5	34200	195	36	36	0.0
Transportation	4	317000	2014	100	110	+10.0
Total industrial	162	3470922	67154	7679	5695	—25.8
Governmental:						
Federal gov't.	12	461067	17149	1947	1404	—27.9
State gov't.	19	123840	4767	764	1075	+40.7
Total gov't.	31	584907	21916	2711	2479	— 8.6
Grand total	193	4055829	89070	10390	8174	—21.3

[a] Not significant.

TABLE 2 EMPLOYMENT OF ENGINEERING GRADUATES BY SIZE OF INDUSTRIAL COMPANIES

No. of employees	No. org.	Total employees	Engineering graduates: Total in organizations	Inexperienced: Hired 1948	Inexperienced: Quotas 1949	Decrease per cent
Less than 5000	77	160686	6732	650	565	13.0
5000–9999	26	177956	4584	526	476	9.5
10000–99999	47	1229311	26348	3474	2404	30.8
100000 and over	11	1902969	29490	3029	2250	25.7
Total	162	3470922	67154	7679	5695	25.8

in those agencies as compared with that relation in the industrial companies has no significance.

Table 2 shows similar data for the industrial companies covered, classified with relation to the total numbers of their employees. It brings out the fact that a substantial number of relatively small organizations are included in the survey and that they employ a significant number of engineers. The higher ratio of engineers to total employees in them, as a group, is due to the fact that a number are consulting organizations, manufacturers of instruments, or in similar highly technical fields, although many others are not of this character. With relatively small employment programs in each company, moreover, their 1949 quotas show only a moderate decrease from 1948.

Table 3 indicates by type of engineering training the number of graduates sought in 1949, by the responding organizations, classified as in Table 1, as estimated from the percentage distributions given in their replies.

In addition to showing the total numbers of graduates from the various curricula sought by the responding organizations, this table brings out the extent to which the different industrial groups and the agencies of the Federal Government employ men of several types. Only the state (including municipal) agencies concentrate on one type of graduate, and this arises largely from the fact that the great majority of those agencies are highway departments.

STARTING RATES

Examination of the data concerning starting rates revealed that very few companies paid different rates to graduates of different engineering curricula, and only a limited number used geographical differentials. There were, however, significant variations between the rates paid by organizations employing primarily chemical engineers and, to a lesser extent, mechanical engineers, as compared with those paid by organizations employing mainly electrical or civil engineers. The significant factor, in other words, appeared to be the market rate which applied to the major types of engineers sought by a company. Table 4, therefore, is set up on that basis. The numbers shown are slightly larger than in the early tables since two or three small companies provided starting-rate figures only. They include those for whom postgraduate training may be desired.

Table 4 gives median starting rates for men with bachelors', masters', and doctors' degrees. Since, however, the number of men with advanced degrees to be employed was not requested, it has been compiled from the rates paid by each company providing data regardless of size. The median rates it gives for bachelors' degrees in certain cases, therefore, differ somewhat from those of Table 5. These differences indicate whether the large organizations tend to pay the higher rates, as in the case of those employing mainly chemical and mechanical engineers, or the smaller organizations tend to do so, as in that of civil engineers.

Cost-of-living allowances used by a number of oil companies and a few other organizations have been included in these figures. The use of any other type of allowance was negligible.

In tabulating these rates, the mid-points of the range of rates used by certain organizations were taken unless other evidence indicated that a different point in the range normally was employed. Although practically no companies had established differentials by curricula, it is probable that some which gave ranges, ordinarily used higher points within them for graduates of certain curricula as compared with others.

As already mentioned, few organizations (12 in fact) indicated that they had set up geographical differentials in their starting rates within the United States, and even in these cases the pattern varied in accordance with the location of their headquarters and character of their work. The most usual differential was for assignment to the West Coast and varied in amount from $15 to $35 per month. In two or three instances, a somewhat smaller differential was paid for New York City and in a similar number of others, lower rates were paid for the south and west central areas.

No more definite geographical pattern is found through tabulation of the starting rates by the locations of the headquarters of the reporting organizations. With one exception the variations which are revealed, seem clearly due to the

TABLE 3, 1949 QUOTAS OF INEXPERIENCED ENGINEERING GRADUATES BY PRINCIPAL CURRICULA AND INDUSTRIAL AND GOVERNMENTAL GROUPS

Employing organizations	No. org.	Engineering curricula: Chemical and ceramic	Civil	Electrical	Mechanical, aeronautical, and industrial	Mining	Other	Total
Aircraft	4	1	11	12	91			115
Automotive	6	36		94	273	37	5	445
Building materials	8	8	3	24	56		1	92
Chemical	12	277	18	35	143	6	17	496
Consulting	4	15	3	7	6			31
Construction	4	6	19	6	21			52
Electrical	8	58	7	746	504		61	1376
Food	9	29	9	3	30	1	4	76
Glass	3	17	3	5	13		1	39
Instruments	8	1	1	45	48		1	96
Machinery	20	15	5	80	208	14	10	332
Metals	16	74	23	54	324	72	18	565
Paper	7	16	4	7	38		2	67
Petroleum	10	253	82	54	197		41	627
Public utility	24	8	43	455	163			669
Rubber	6	100	11	21	155	1	15	303
Shipbuilding	2			1	6		10	17
Soap	2	64		22	58		7	151
Textiles	5	12		1	12		11	36
Transportation	4		79	16	15			110
Total industrial	162	990	321	1688	2361	131	204	5695
Governmental:								
Federal gov't	12	65	591	266	385	58	39	1404
State gov't	19	11	1038	6	13	2	5	1075
Total gov't	31	76	1629	272	398	60	44	2479
Grand total	193	1066	1950	1960	2759	191	248	8174

TABLE 4 MONTHLY BASE STARTING RATES ENGINEERING GRADUATES WITH BACHELORS' DEGREES BY PRINCIPAL CURRICULA USED IN EMPLOYING ORGANIZATIONS

Principal curricula	1949 quotas	Median[a] upper half	Median[b] whole group	Median[c] lower half
Chemical or ceramic	1507	300	290	270
Civil or structural	2092	260	250[d]	250[d]
Electrical	2328	255	250	245
Mechanical, aeronautical or industrial	2182	275	265	250
Other	125	275	250[d]	250[d]
Total	8234	275	255	250

[a] Exceeded (or equaled) by 25 per cent of cases.
[b] Exceeded (or equaled) by 50 per cent of cases.
[c] Exceeded (or equaled) by 75 per cent of cases.
[d] Identical, due to heavy concentration of cases at this rate.

TABLE 5 MONTHLY STARTING RATES MEDIANS BY EDUCATIONAL LEVELS

Principal curricula	Bachelors: Number[a]	Bachelors: Rate	Masters: Number[a]	Masters: Rate	Doctors: Number[a]	Doctors: Rate
Chemical or ceramic	40	$275	36	$310	31	$400
Civil or structural	31	255	17	275	7	295
Electrical	41	250	24	280	10	375
Mechanical, aeronautical, or industrial	79	255	46	300	27	350
Other	7	250	2	315	2	375
Total	198	255	125	300	77	375

[a] Of organizations reporting.

character of the organizations concentrated in particular areas rather than to geographical factors. That exception again is on the Pacific Coast where a median rate of $300 seems to be independent of such influences. The total number of positions reported by companies with headquarters in that area, is only 250.

Tabulation of starting rates by industrial and governmental groups does bring out some significant differences and makes it clear that the differing market rates for graduates of the several curricula are greatly influenced by the industries seeking men from those curricula. Table 6 presents the medians for those groups which contain a number of organizations employing a substantial total number of graduates.

Tabulation of these rates for industrial companies by size of organization indicates that slightly lower rates (median $250) are paid by companies with fewer than 5000 employees. For the larger companies, although some variations occur, they seem to be determined primarily not by company size but by the industry and curriculum from which they are seeking graduates.

Fifty-five of the 193 organizations returning questionnaires reported that they gave a differential for military service. In 33 of these cases, its amount was stated as based on the value of the individual's military experience to the organization, and, in 14 cases, it was based on "individual consideration," a very similar criterion. In the remaining cases, other reasons, such as length of time in military service, was the determining factor. Companies employing mainly chemical or electrical engineers were most likely to pay such differentials;

TABLE 6 MONTHLY STARTING RATES ENGINEERING GRADUATES WITH BACHELORS' DEGREES BY INDUSTRIAL AND GOVERNMENTAL GROUPS

Employing organizations	No. of Organizations	1949 quotas	Median rates
Industrial:			
Automotive	6	445	$275
Chemical	13	504	290
Electrical	8	1376	245
Machinery	20	332	245
Metals	16	565	260
Petroleum	10	627	300
Public utilities	23	665	260
Rubber	6	303	270
Total Industrial[a]	162	5695	260
Governmental:			
Federal	12	1404	250
State	19	1075	250

[a] Including other industries not listed.

those employing mainly mechanical engineers seemed least likely to do so. The proportion of the companies with more than 10,000 employees paying this differential was about double that of the smaller companies, and a somewhat higher proportion of the private companies than of the governmental organizations did so.

Table 7 presents data concerning the practices of the responding organizations with regard to increases during the first year of employment. The data are given by organizations with no attempt to weight them for the number of graduates hired. No analyses by industry, size of organization, or region, moreover, were undertaken. A few organizations did not provide this information.

The final item concerning starting rates covered those paid to graduates in business administration and liberal arts, as compared to engineering. Table 8 set up by organization only without regard to numbers of men hired presents data on this point. The relative numbers of organizations indicate the extent to which organizations seeking engineering graduates employ enough business or arts graduates to set a rate for them.

TABLE 7 SALARY INCREASES DURING FIRST YEAR OF EMPLOYMENT BY PRINCIPAL CURRICULUM USED

Principal curriculum	No. of organizations	No. of increases[a] 1	2	3 or 4	Automatic	Merit	Medians, per month[b] Top half	All	Lower half
		(Percentage of totals)					(Totals for year)		
Chemical or ceramic	39	44.1	55.9	0.0	28.2	71.8	$40	$25	$20
Civil or structural	29	69.6	26.1	4.3	48.3	51.7	30	20	10
Electrical	41	38.5	46.1	15.4	48.8	51.2	45	30	20
Mechanical, aeronautical, or industrial	76	39.7	54.4	5.9	36.8	63.2	45	30	25
Other	5	50.0	25.0	25.0	0.0	100.0	..	45	..
Total	190	44.6	48.8	6.6	38.4	61.6	45	30	20

[a] Excluding 20 companies determining intervals on individual basis.
[b] Excluding 22 companies determining amounts on individual basis.

TABLE 8 MONTHLY MEDIAN SALARIES FOR ENGINEERING, BUSINESS, AND ARTS GRADUATES BY PRINCIPAL ENGINEERING CURRICULUM USED

Principal engineering curriculum	No. of organizations reporting Engg.	Business	Arts	Medians Engg.	Business	Arts
	Bachelors' Degrees					
Chemical and ceramic	40	31	27	$275	$250	$250
Civil and structural	31	14	8	255	240	235
Electrical	41	27	21	250	250	250
Mechanical, aeronautical, and industrial	79	47	37	255	250	250
Other	7	5	4	250	250	235
Total	198	124	97	255	250	250
	Masters' Degrees					
Chemical and ceramic	36	18	17	310	300	300
Civil and structural	17	7	5	275	275	275
Electrical	24	13	9	280	285	285
Mechanical, aeronautical, and industrial	46	21	17	300	275	260
Other	2	3	2	315	280	250
Total	125	62	50	300	275	275

TABLE 9 MONTHLY SALARIES ENGINEERING GRADUATES 10 YEARS AFTER BACHELORS' DEGREE BY PRINCIPAL CURRICULUM USED BY EMPLOYING ORGANIZATION

Principal curriculum	No. org.	No. grads	Median upper half	Median whole group	Median lower half
Chemical or ceramic	20	484	$550	$480	$450
Civil or structural	13	235	450	400	385
Electrical	23	646	425	410	400
Mechanical, aeronautical, or industrial	34	343	550	500	465
Total	91[a]	1718[a]	500	440	410

[a] Including one mining with 10 cases.

The figures given in Table 8 indicate relatively uniform rates for the business and arts graduates, particularly at the bachelors' level. The greatest differences between such graduates and those in engineering, therefore, are shown for organizations which pay the higher rates for the latter. As a matter of fact, of all reporting organizations, about one half pay the same rates to bachelors in business and arts as to those in engineering, one half pay lower rates, and practically none pay higher rates. At the masters' level, about two thirds of the organizations pay the same rates to the nonengineers, and one third pay lower rates. Organizations employing mainly electrical engineers, generally pay the same rates, and those employing mainly chemical engineers in most instances pay lower rates for the nontechnical men.

Salaries of Graduates 10 Years Out of College

In recognition of the fact that many organizations would not have data concerning the salaries of graduates with several years of experience in their organizations readily available, the questionnaire sent out requested current information of this sort only for men 10 years beyond their bachelors' degrees and made it possible to present such data either as an estimate or as the result of a definite compilation. In addition, comparable data were requested for the fall of 1946, in order that the current figures might be related to those reported in the volume, "The Engineer in Transition." In wording the questions, special care was taken to insure that the men considered represented those 10 years beyond their bachelors' degrees in each year.

Of the 198 organizations furnishing starting rates, 91 provided data on this point, 48 of them based on definite compilations, 43 as estimates. The resulting figures, however, varied only slightly for the two groups, and it seems reasonable to present combined totals without serious question concerning their reliability. These are given in Table 9, set up on the basis of the principal curriculum from which the employing organization now seeks its engineering graduates. In general, that corresponds closely with the one from which these men of 10 years' standing have been drawn, despite a few shifts in individual companies.

Analyses of these data by specific industries, size of organization, or geographical area gave results which seem reliable only in one or two groups in each series, or are heavily weighted by a single organization. Comparisons on these bases, therefore, appear likely to be misleading and, accordingly, are not presented.

Table 10 presents the comparative data secured by this survey for 1948 and 1946, and the corresponding 1946 data presented in "The Engineer in Transition." No specific table in that publication exactly paralleled the current figures but an extremely close approximation has been made through combining tables it contained.

It is interesting to note that the current survey covers more cases of this degree of maturity than the earlier one. The latter, however, using individual returns, undoubtedly covered a wider range of employers and this fact presumably is reflected in the greater spread of salaries within the middle half of the groups. The moderate difference in the medians of those groups as a whole may be due either to chance factors or to the fact that the earlier questionnaire went only to members of the engineering societies whose salaries are likely to be somewhat above those of all graduates. In any case, the general level of such salaries for men 10 years out in 1946, seems rather well established and the 1948 figures from the current survey would seem reasonably reliable.

TABLE 10 MONTHLY SALARIES ENGINEERING GRADUATES 10 YEARS AFTER BACHELORS' DEGREE

Present survey	No. of cases	Median upper half	Median whole group	Median lower half
1948	1718	$500	$440	$410
1946	1747	435	380	360
Engineer in transition 1946	1085[a]	465	395	335

[a] One third of 2667 graduates in private employment and 559 in public employment (total 3256) with 9–11 years of professional experience.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Education

ARGUMENTS for and against the proposal to extend the conventional four-year engineering course to five years, were presented at the 1949 ASME Spring Meeting held in New London, Conn., in a panel discussion sponsored by the ASME Education Committee.

The first paper, "Some Trends in Education and the Proposed Five-Year Engineering Curriculum," by Carroll V. Newsom, New York State Education Department, Albany, N. Y., analyzed the four trends that are significant in considering the extension of the four-year curriculum to five years. They are as follows: The growing emphasis on general education on the secondary level; the development of technical-institute programs to stand between vocational and professional programs; the growing conception that the term "engineer" should denote a person with a broad educational background; and the rapid increase in the cost of education. Although Mr. Newsom did not take a stand either for or against the proposed five-year course of study, the first three trends may be regarded as providing an argument in favor of it.

K. B. McEachron, Jr., Mem. ASME, General Electric Company, Schenectady, N. Y., in a second paper entitled, "An Experiment in Engineering Education," said that the responsibility of engineers is above and beyond that of producing materials and machines. The engineer also has a definite responsibility to see that the devices he has created are used constructively. The recognition of this responsibility culminated in the Report of the American Society for Engineering Education After the War, made by the ASEE. In accordance with their recommendations, many schools now include in their engineering curriculums subjects with humanistic and social implications. Expanding this part of the program materially, however, is possible only at the expense of technical courses. Several large universities have answered this problem by establishing a five-year undergraduate curriculum. The analysis of the product of this five-year course should wait until these graduates have been in industry long enough to be compared with those from the conventional four-year course. In the meantime, it is just as important for those colleges with four-year programs to revise and improve them as it has been for certain colleges to pioneer in organizing a five-year curriculum.

The third paper, "Humanities in the Engineering Curriculum, a Related Experience," was presented by S. W. Dudley, Fellow ASME, Yale University, New Haven, Conn. Dean Dudley discussed the definitions and meaning of education, the educated person, and emphasized the student rather than education. A great impetus in the humanistic studies in engineering education was given by the findings of a seven-year study of engineering education here and abroad during the early 1920's by Dr. W. E. Wickenden and Dean H. P. Hammond. It disclosed a growing demand for men who were not only broadly trained in scientific and engineering fundamentals and their applications in special fields, but who were also acquainted to some extent with the elements of related fields, especially with regard to dealings with people. To assist the student toward this development, seminars carrying one-hour credit per term were included in the junior and senior class programs of each of the departments of engineering at Yale in the early 1920's. These were operated independently and the procedures arranged as seemed desirable to the department concerned, but the weekly meetings were all scheduled for the same day and hour so that occasional joint meetings could be held. For example, the department of electrical engineering at that time initiated a comprehensive program aimed to give the student experience in acquiring, under direction, an active and growing interest in significant achievements in English literature, history, and in the social sciences as related to the social and economic aspects of engineering activities. In the department of mechanical engineering, the seminar took the form of weekly meetings of the Yale ASME Student Branch with assigned student speakers. Reading from manuscript was discouraged. Complete freedom was allowed in the choice of subjects save for a taboo on religion and politics. The student was uged to speak about something of which he had either personal knowledge and experience, or an impelling curiosity. About once a month an outside speaker would address the seminar. The department of psychology provided a course of six lectures on "Why People Behave As They Do." These weekly experiences in standing before an audience, having something to say, and saying it, furnished weekly opportunities for each student to

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

acquire from his own experience, as well as from those of his fellows, some understanding of the fundamentals in "the art of utilization of knowledge" in the process of communicating his own ideas to his associates.

"The Smaller Employers' View on the Five-Year College Course," was given in a fourth paper by B. P. Graves, Fellow ASME, Brown and Sharpe Manufacturing Company, Providence, R. I., who spoke from his lifelong association with the machine-tool industry and is decidedly against prolonging engineering education another year. He said that educators are endeavoring to teach too little of too much, and the student is coming into industry lacking a solid training in the fundamentals essential in the field of machine design. Mr. Graves believes that more effort should be put into teaching logical thinking, analytical methods of solution, and critical selection of the results, and writing, but not by the addition of another year of undergraduate study.

In the last paper presented at the symposium, "What Does Industry Expect of Engineering Curricula?" R. H. McCarthy, Mem. ASME, Western Electric Company, Kearny, N. J., said that there is a widespread impression that the proposed fifth year is to allow time for humanistic subjects that cannot be placed in a four-year course. To refute this, however, he quoted from a recent engineering-college catalogue as follows: "The five-year curriculum is arranged to provide not only stronger technical instruction than is contained in the usual four-year course, but also to include training to develop leadership in this field. Also, the student has an opportunity to select other courses, liberal or otherwise . . . ." There is no requirement that these electives be "liberal." Therefore, this fifth year has more engineering as well as humanities as its objective, he said.

Mr. McCarthy pointed out, however, that most graduate engineers are in operations and manufacturing planning. They get sufficient engineering in four-year curriculums to make a good start. If student, faculty, and society, in general, believe that the course is too intensely technical and more of the humanities are needed, the four-year course can still handle the problem by reformulation of the scientific and engineering subjects. The specialists in design and developments are an important but much smaller group. They might well receive a five-year training, but this too should provide some of the studies which give perspective to life and a truer sense of human values, i.e., the humanities.

Double-Sampling Plan

A MODIFIED double-sampling plan has been developed by J. M. Cameron and W. J. Youden in the Statistical Engineering Laboratory of the National Bureau of Standards, in Washington, D. C., that makes possible a saving in the average amount of inspection that may range from 20 to 40 per cent.

One common inspection method involves single sampling. By this scheme, a single sample of a fixed number of units is drawn at random from the material under test. Acceptance or rejection may depend upon whether or not the average of the individual test results is greater than a predetermined limit or upon whether the number of good items exceed a fixed acceptance number. The first method is usually referred to as "variable inspection" and the second as "attributes inspection." In either case, only a single acceptance number is needed.

In the case of ordinary double sampling, an interruption is made at a predetermined point, and if the test results are sufficiently one-sided the material is either accepted or rejected. If the evidence is indecisive, a fixed number of additional units is drawn and the results are combined and treated as in single sampling.

Another inspection method in common use is sequential sampling. In this scheme, the test results are accumulated unit by unit until the evidence is sufficiently one-sided to justify acceptance or rejection of the lot. A table or graph of acceptance and rejection values for sequential sampling requires acceptance and rejection values for the first sample, and the acceptance value for the combined first and second samples.

The modified double-sampling plan, developed at the Bureau, is a substitute for the usual single-sampling plan that does not alter the sampling itself or require additional computation. In this new plan the same number of units is drawn as in the single-sample case, but the regular testing procedure is interrupted after a fixed number of items have been tested. If a predetermined number of these test results individually exceed the acceptance value of the original plan, the material is immediately accepted and testing stopped. If less than the required number meet the acceptance value, testing is completed in the usual way and the individual test results are averaged. Acceptance or rejection then depends on whether or not this average exceeds the acceptance value.

Labor-Management Co-Operation

ACCORDING to a two-year study made by the American Management Association on "Greater Productivity Through Labor-Management Co-Operation," labor-management co-operation seems to be much more prevalent than it was a decade ago. This study was undertaken in response to requests from many member companies which were anxious to know whether certain types of labor-management co-operation could be used to arouse greater interest in output on the part of individual employees and to reduce friction in day-to-day dealings with unions.

This report follows AMA policy of merely identifying problems of prime importance in the field of management and doing research on a chosen subject without being partisan. This study covered the methods for unions or groups of employees co-operating with management on the following: (1) describing output standards (equitable wage distribution through job evaluation); (2) establishing output standards (time measurement for a fair day's work); (3) meeting output standards (joint fact finding and information, improvement of discipline and absenteeism); (4) improving output standards (improving employee suggestions, accident prevention, training, waste and quality control, increasing over-all productivity).

Material was obtained both by questionnaires and from 40 plant surveys in the field which included hundreds of interviews with production and personnel men, union officials, and individual employees.

Among the principal findings of the AMA are the following: Co-operation's capacity to survive is considerable; where co-operation has been successful in unionized companies, it appears to have narrowed the field of disagreement between management and union; many companies both unionized and non-unionized, claim that co-operation has resulted in improved employee attitude; co-operation is most heavily concentrated in medium-sized firms; and co-operation appears to have a greater chance of success when started during periods of prosperity.

There is considerable doubt whether the movement will grow sufficiently to exert a major influence on industrial relations, but the possibility exists. At the present time, co-

operation seems to be spreading if very slowly. Experience has not been conclusive enough to warrant recommendations, pro or con. AMA hopes only that the case stories and discussions in its report will enable companies, which may be considering the idea, to weigh their chances of success more realistically and calculate the possible risks more accurately.

Track-Tread Landing Gear

TAXI tests were successfully completed recently on the first B-50 medium bomber equipped with track-tread landing gear.

A 164,000-lb B-50 improved version of the wartime B-29 Superfortress was used in tests conducted at the Seattle, Wash., plant of the Boeing Airplane Company.

A new experimental landing gear is being used to investigate possibilities of utilizing unimproved unpaved runways for operation of heavy aircraft, such as medium bombers, tankers, and transports. Other aircraft already have been equipped with the tractor-type landing gear.

Consisting of a double tractorlike rubber tread for the main landing-gear units, and a single tread unit in place of the nosewheel, the new system completely retracts when the plane is in flight and top speed of the 400-mph bomber will not be affected.

Largest installation of its type, the track-treads have a "footprint" area three times that of the usual double tire landing gear of the Boeing B-50. Each landing gear unit consists of an endless rubber and steel wire belt, which rotates around a series of grooved drums and bogies, and resembles a tread system on an Army tank. Rubber belt treads on double main units are each 20 inches wide, and have a ground contact 46 in. in length. The nose gear ground contact area measures 16 × 36 in. The nose gear retains hydraulic steering features of the standard B-50.

The landing gear was designed by Boeing. The main gear trucks and belts were manufactured by the Goodyear Tire and Rubber Company. Nosewheel truck and tread was built by the Firestone Tire and Rubber Company.

Gear-Lubricant Testing

RECENT investigations at the National Bureau of Standards by S. A. McKee, J. F. Swindells, H. S. White, and Wayne Mountjoy have shown that the SAE extreme-pressure-lubricants testing machine can be adapted to measure accurately the wear obtained with various automotive gear lubricants under simulated service conditions. This apparatus—originally designed for testing load-carrying capacity of gear lubricants under fixed high speed and shock loading—provides a sensitive means for the evaluation of lubricants with respect to wear at high torque and low-speed operation. The new test therefore makes it possible to detect any significant difference in the performance of lubricants meeting the requirements of the same specifications.

Of the various laboratory testing machines commonly used in the study of automotive gear lubricants, the SAE machine more nearly simulates gear operation. Two contacting cylindrical test cups of this machine are rotated at different speeds under load, providing a combined rubbing and rolling action that is typical of loaded gear teeth. A further similarity is a constantly changing line contact with respect to the surfaces of both cups, hence no one point on the periphery is under continuous stress.

The machine is particularly adaptable for wear tests because

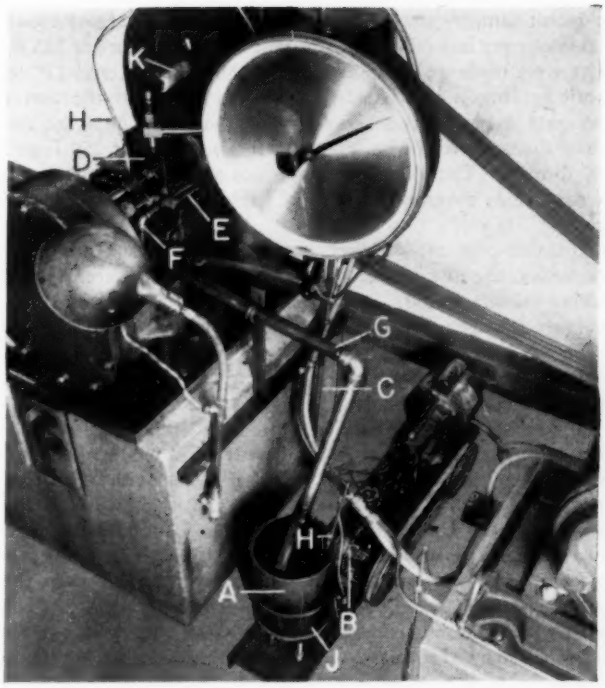

FIG 1 MODIFIED EXTREME-PRESSURE-LUBRICANTS TESTING MACHINE

(By means of a special oil-circulating system, oil from reservoir A is drawn through pipe C to upper test cup which is covered by splash guard D. The oil then drains to box E, hence through overflow pipes F into the drain pipe G and back to the reservoir. Heaters are located at J and K and thermocouples at H.)

the test specimens are of such size and shape that accurate indications of wear may be obtained by determination of loss in weight. Also, any wear that occurs on the test cups does not materially affect the area of contact under a given load. On the other hand, the method of lubricating the test surfaces is not especially suitable for long-time tests, and it was necessary to modify the machine in this respect.

In the modified lubrication system, Fig. 1, the oil being tested is drawn from a reservoir by a motor-driven pump and delivered through a $^1/_4$-in. pipe to the top of the upper test cup which is covered by a special oil splash guard. The oil then drains to the oil box which is fitted with two $^1/_4$-in. overflow pipes so located that the oil level in the box partially immerses the lower test cup. The oil from the overflow falls into open fittings in the $^3/_4$-in. drain pipe and returns to the reservoir. Heat is applied to the oil reservoir and delivery pipe, while thermocouples in the oil box and oil reservoir provide a means for temperature measurement and control. Counterbalanced overflow pipes, splash guards, and an oil thrower prevent excessive oil leakage around the test cups and oil box.

The lubricants used in the Bureau's investigations were SAE 90 grade and included a Navy contract 1080 mineral oil, five lubricants conforming to U. S. Army Specification 2-105B, five lubricants conforming to Federal Specification VV-L-761, and one lead-soap active-sulphur lubricant.

In these wear tests, the upper cup is driven at a speed of 500 rpm with a 3.4 to 1 gear ratio between the upper and lower cups, thus providing a 2.4 to 1 ratio of rubbing to rolling at the contacting surfaces. The specimens, steel Timken test cups (T-48651), have an average (rms) surface roughness of from 25 to 30 microinches as measured with the Profilometer. Each

lubricant sample (two quarts) is circulated at a rate of about 500 grams per min. With a constant oil temperature of 225 F, tests were made at constant loads of 90, 135, 180, and 225 lb (scale readings). The loading system is such that the corresponding loads on the 2-in-diam × $^1/_2$-in. test cups are ten times the scale readings. Tests were also made at 250 F and 180 lb load. The foregoing conditions approximate the range of conditions covered in the usual high-torque low-speed gear tests.

The test cups are weighed before and after each period of operation, the loss in weight being used as a measure of wear during the test period. At the beginning of the investigations, weighings were made at frequent intervals, and the tests were run for as long as 75 hr. It was found, however, that representative data could be obtained by operating for about 25 hr, with weighings after 4, 11, 18, and 25 hr operation.

In general, the data obtained in these tests indicate that there is a run-in period of high rate of wear for a few hours, after which the wear settles down to a fairly constant rate. In a graphic plot of such data, see Figs. 2 and 3, the straight portion of the curve usually is well established by 25 hr of operation. The slope of this portion of the curve is more significant from the standpoint of estimating gear life than the observed loss in weight for any given length of time. At the higher loads the rate of wear with some of the lubricants tested showed a marked increase, whereas with others there was little effect.

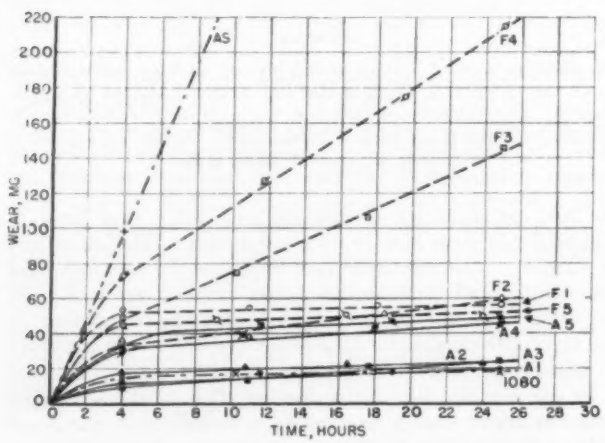

FIG. 2 WEAR VERSUS TIME CURVES FOR ALL LUBRICANTS (SAE 90) OPERATING AT 135 LB LOAD AND 225 F

(Lead-soap active-sulphur lubricants, AS; Army specification 2-105B lubricants, A; Federal specification VV-L-761 lubricants, F; Mineral oil, 1080.)

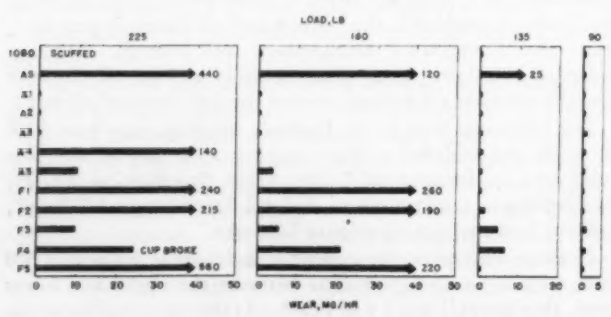

FIG. 3 BAR GRAPHS OF THE RATE OF WEAR—AFTER RUN-IN PERIOD—IN MILLIGRAMS PER HR FOR ALL LUBRICANTS AT 225 F WITH LOADS OF 225, 180, 135, AND 90 LB

Although wear data with hypoid gears are not available for a direct comparison, it is believed that these results are in reasonable agreement with the known service performance with these lubricants. The wear with the mineral oil was low up to the point where it would not carry the load, while with the lead-soap active-sulphur lubricant (which will carry a high shock load) the wear was relatively high at all but the lightest load.

In most of the tests, Profilometer readings of the surface roughness of the test cups were obtained at intervals during the test run. For those tests where the rate of wear was relatively low, the roughness decreased in the run-in period and tended to level off in a range between 10 and 20 microinches. As the rate of wear increased, there was a trend for the roughness to increase. This was especially noticeable in cases of excessive wear where there was definite "ridging" of the cups, which in some cases was beyond the range of the Profilometer.

Besides offering a sensitive measure of the rate of wear with different commercial gear lubricants, the new test provides evidence of run-in wear which is of considerable importance. This should be taken into account in the evaluation of lubricants with respect to wear. Still another advantage is that the rate of wear after the run-in period is not materially affected by the original roughness of the test cups, as is the case with the usual load-carrying-capacity tests with this machine.

The lubricants containing the more chemically active additives for withstanding higher shock load tend to show the greater wear. This is in agreement with the known service performance of some of these lubricants particularly the active-sulphur lubricant and the nonadditive mineral oil.

Air Force Research

AMERICA'S aircraft engineers and airplane builders now know how to produce operational combat airplanes capable of supersonic speed, General Joseph T. McNarney, Commanding General of the Air Materiel Command, declared, according to the June 1, 1949, issue of the CADO *Technical Data Digest*. But, he added, the U. S. Air Force is planning to wait until at least three more supersonic research ships like the Bell X-1 have been evaluated.

He also predicted that a 12,000-lb bomb that can be guided all the way to the target will be ready for operational use within a year. He did not disclose any details of the steerable bomb.

General McNarney reported that the Air Force had abandoned all research on reciprocating engines and is now developing 12 new jet power plants, including ramjets, pulsejets, turbojets, and turboprops. He revealed that "several" new experimental jet bombers are being developed.

Included are a light bombardment airplane designed to support ground troops, a medium bomber to replace aircraft like the Boeing B-29 and B-50, and a long-range heavy bomber. If this latter proves feasible, it may complement or replace the Convair B-36, which is equipped with six reciprocating and four jet engines.

The following new U.S.A.F. research and development projects were also revealed by the General:

1 Aerial cameras capable of taking clear detail pictures from altitudes of 40,000 to 100,000 ft. Negatives are so sharp that railroad ties can be counted. These have already been perfected.

2 A multistage rocket missile capable of attaining about 4000 mph. It would be launched from the ground in defense against attack by enemy missiles approaching from beyond the atmosphere of the earth. Development of such a missile is not likely before "perhaps a decade," General McNarney said.

3 "Great progress" has been made by American research engineers toward development of devices to guide missiles with speeds up to 700 mph and ranges up to 5000 miles. But pinpoint accuracy has not been reached. General McNarney emphasized that "push-button warfare" with such missiles "is still in the rather distant future."

4 Conventional machine guns on interceptors "within a relatively short time" will be replaced by rocket missiles having a built-in radar homing device. This device will guide the missiles directly to an enemy bomber regardless of any evasive action by the bomber. The general said these rockets will be launched several miles from an enemy bomber, track it down at supersonic speed, and explode within lethal range by means of a proximity fuse.

Gas-Turbine Automobile

A HYPOTHETICAL gas-turbine-powered automobile was described by William A. Turunen of the General Motors Research Laboratories, in a paper presented at the 1949 summer meeting of the Society of Automotive Engineers, held in French Lick, Ind., recently. It was compared with a 125-hp conventional engine in a 5000-lb automobile.

He said it probably would be propelled by a dual-turbine arrangement, consisting of a compressor, combustion chamber, compressor turbine and power turbine—the simplest form of the turbine engine which can be called adaptable to road vehicle use.

A turbine-driven compressor, referred to as the gas-generator unit, would operate independently of the power-turbine unit, which supplies power or torque to the motor-car drive shaft. The gas-generator unit utilizes only enough energy from the hot gases to drive the compressor, leaving most of the high-energy gases for the power turbine. Thus the two units, in effect, would be gas-coupled.

This arrangement, Mr. Turunen explained, would give maximum torque with the drive shaft stationary. The compressor and gas generator could operate at maximum efficiency, while the power turbine would maintain torque and speed to suit the demand of the motorcar driver.

He pointed out that although the gas turbine has often been described as a simple machine with one working part, this simplicity may be deceptive. A complete installation is a bulky group demanding the utmost in design effort if machinery space is to be prevented from overrunning the passenger cargo space. This is due primarily to large air requirements demanding space-consuming ducts.

According to the paper, the automotive gas turbine would face the following disadvantages when compared with the conventional reciprocating engine:

1 Fuel consumption for gas turbines is high, especially at part throttle. At maximum or "design point" speeds the turbine compares "not too unfavorably with the conventional engine."

2 Controls and limiting devices must be developed to insure safe operation, a problem that still harasses the aircraft industry. These controls must be foolproof because the average motorist is not a technician.

3 Space requirements appear large. The air-flow system of a 125-hp turbine, which was chosen for the study, must accommodate greater air volumes than a conventional engine of the same power rating.

4 Lower first cost appears questionable. Materials to withstand high temperatures generally are costly and difficult to fabricate.

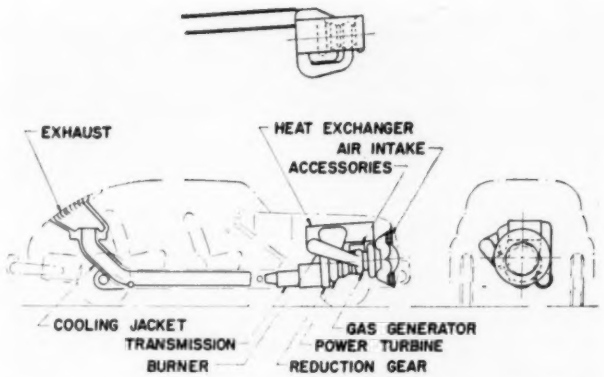

FIG. 4 SCHEMATIC DIAGRAM SHOWING A GAS TURBINE INSTALLED IN A CONVENTIONAL AUTOMOBILE PROFILE

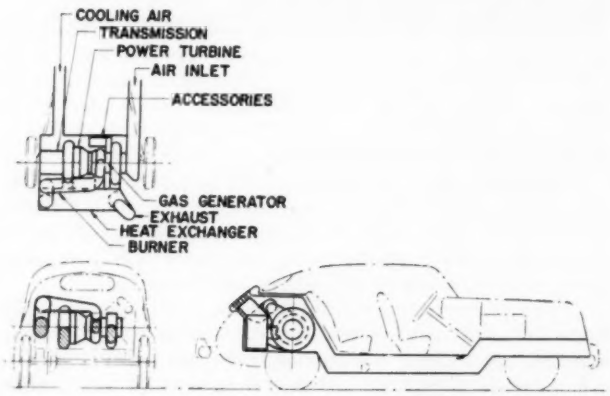

FIG. 5 DIAGRAM SHOWING REAR-ENGINE GAS-TURBINE INSTALLATION

5 Lower maintenance cost is doubtful, especially if high temperatures are used. Efficient turbines operate at high temperatures.

6 Exhaust may be objectionable.

7 Turbine performance is more sensitive to changes in prevailing temperatures than reciprocal engine performance.

8 A separate device to produce braking torque may be required inasmuch as the turbine is a free-wheeling device.

9 Silencing may present a difficult problem.

10 A large reduction gear ratio is required.

11 The power required for automotive use is too low to show turbines at their best advantage. Best results are attained with turbines of large power capacity.

At the same time, Mr. Turunen listed the following advantages the gas turbine would have over conventional engines:

1 It may operate with a wide range of fuels.

2 Absence of power impulses, such as power thrusts, probably would reduce the vibration problem.

3 Lubrication may be simplified.

4 Electric ignition is required only for starting.

He indicated further that a turbine-powered auto would offer the individual motorist additional features such as, maximum torque at standstill with uniform torque over its entire speed range, a transmission with only one ratio change, and possibly no clutch mechanism.

But the latter three features, Mr. Turunen explained, also are realized when a conventional engine is outfitted with an automatic transmission.

The success of the gas turbine in the automotive field is dependent on future developments, he stated, and these must keep abreast with refinements in design appearing in the reciprocating engine. Unless the gas turbine can promise performance beyond the bounds attained by the reciprocating engines, its sphere of influence in the automotive field will be restricted.

Safety

ACCORDING to a report of the National Safety Council, last year's industrial injury rates show a substantial reduction in both frequency and severity of accidents to employees as compared with 1947.

The accident frequency rate for all industries submitting company reports to the Council, based on the number of disabling injuries per 1,000,000 man-hours, was 11.49 in 1948—a reduction of 13 per cent from the year before.

The communications industry again led all other industries by turning in the lowest frequency rate. Its rate was 2.60—a 13 per cent reduction from 1947. The aircraft manufacturing industry was second best with a frequency rate of 4.56. This was a reduction of 36 per cent and brought the aircraft-manufacturing industry up from fifth-place standing in 1947.

Lumbering was at the bottom of the frequency list in 1948, with a rate of 49.04, but this represented a reduction of 18 per cent from the year before. Coal mining, which ranked next to the bottom of the frequency list in 1947, ended 1948 in the same position with a rate of 46.09—a 15 per cent reduction.

The accident-severity rate for all industries reporting to the Council, based on the number of days lost per 100 man-hours, was 1.12 last year—a reduction of 9 per cent from 1947.

Communications again had the lowest severity rate, leading all other industries last year with a ratio of 0.18—a 13 per cent increase over 1947. The tobacco industry ranked second in 1948 with a rate of 0.19, a reduction of 21 per cent from the previous year, when it was in fourth place.

In terms of severity, coal mining once more stayed at the bottom of the list with the highest accident-severity rate of 7.61. But this was a 4 per cent reduction from 1947. Mining, other than coal, ranked second from the bottom both years, but its 1948 rate of 6.37 was worse by 3 per cent than the year before.

Adhesion

THE nature of adhesion has become the subject of a fundamental research program at the National Bureau of Standards. Sponsored by various Government agencies, this project was initiated in 1945 with a survey of the literature on adhesives and the theory of adhesion. Because of the dearth of comprehensive data in this field, the Bureau extended this program to include investigations of the adhesive properties of a wide variety of adhesives and adherends.

Among the adhesives included in the investigation were cellulose nitrate, polyvinyl acetate, resorcinol formaldehyde, casein, gum arabic, natural rubber, and neoprene. These were modified as little as possible so that the relation between adhesive and adherend would be due to the simplest possible combination. The adherends chosen, aluminum alloy, stainless steel, paper phenolic laminate, plate glass, birch wood, and hard rubber, are a fair sampling of the materials of industry, have a wide range of elastic moduli—the property best correlated with bond shear strength—and their chemical and physical structures makes possible a variety of adhesive bonds.

Test specimens were prepared using each adhesive in turn with each adherend; only one adherend was used in any one specimen. The proper treatment of the adherend surface was found to be of primary importance since, when exposed to ordinary atmospheric conditions, it usually picks up impurities in the form of oxide, dust, or oil films. If dirt or impurities are present, close contact between the adhesive and the base adherend surface is prevented and the best adhesive action is not obtained.

Specific bonding conditions for the test assemblies were developed for each adhesive, depending on the chemical and physical nature of the adherend. These conditions ranged from 3 psi pressure, for a gum-arabic adhesive, dried 20 hr at 25 C, to 150 to 200 psi pressure, for a rubber adhesive cured 7 hr at 140 C.

The specimens, after conditioning for a minimum period of seven days at a temperature of 25 C and 50 per cent relative humidity, were tested at the same temperature and humidity for shear, tension, impact, and fatigue properties. All combinations were subjected to the shear and tensile tests. The impact test provided a means for studying differences between a brittle and a rubbery bond, and the fatigue test was utilized to investigate how a thermosetting and a thermoplastic bond differ.

Except for glass specimens bonded with polyvinyl acetate and cellulose nitrate, a tensile shear load, applied to a double-lap-joint specimen, was used in every case for the shear-strength determination. Glass proved too brittle when subjected to tensile-shear loads of more than 200 to 300 psi. However, compression-shear specimens were able to withstand loads of more than 2500 psi.

Tensile-adhesion values were obtained by using dumbbell-shaped specimens with contact areas of 1 sq in., $^1/_2$ sq in., and $^1/_4$ sq in. When the adherends were much weaker than the adhesives, dumbbell-shaped specimens with the smaller contact areas were prepared in order that the specimens would fail at or near the bond interface.

The rate of loading in both the shear and tensile tests was adjusted within the limits of 200 to 1000 lb per min so that failure of the bond would occur after approximately three minutes. Thus the time of fatigue would be about the same for all specimens.

The fatigue properties of thermoplastic and thermosetting resins were studied by using a double-lap tensile-shear specimen with a $^1/_2$-in. overlap. By varying the width of such specimens—to which a 50 or 100-lb weight was attached—a range of shear stresses from 200 to 1300 lb was obtained. Impact-resisting properties of rubbery and brittle cements were compared, using single-lap specimens of both aluminum alloy and wood. These specimens were broken with a pendulum impact machine of 2 ft-lb capacity.

An evaluation of the data gathered in this project was obtained by tabulating the result with respect to two fundamental properties of the materials involved. These are dielectric constant and modulus of elasticity, the former an electrical and the latter a mechanical property. The dielectric constant was considered to be of possible importance since most modern theories attempt to explain adhesion on the basis of electrical forces.

The tabulations tended to show greater correlation with the moduli of elasticity than with the dielectric constants. When a high-modulus adhesive was used with a high-modulus adherend, the bond strength was negligible. When a low-modulus material was used, its strength became the limiting factor in the strength of the bonded assembly. The best results were obtained when medium-modulus materials were used with each other or with high-modulus materials. For

instance, resorcinol formaldehyde, a high-modulus adhesive, provided no adhesive action with glass and metals, both of which are high-modulus adherends. However, it gave good results with wood, a medium-modulus adherend. Polyvinyl acetate, a medium-modulus adhesive, gave consistently good values with all the adherends.

Results of these investigations indicate that there are many variables involved in adhesion and that the breaking stress of a specimen is not always a measure of the adhesive-adherend bond strength. Instead it may be a measure of the cohesive strength of the adhesive or the adherend. A break at the adhesive-adherend interface, for example, may be attributed not so much to lack of adhesion as to the overshadowing effects of strains produced by temperature differentials or by adhesive layer shrinkage due to solvent evaporation.

Chemical action between the adhesive and the adherend may also result in loss of strength in the bond assembly. This may be due to the weakening of the adhesive or adherend because of the chemical action, or it may be due to the formation of a weak chemical layer at the bond interface.

Self-Supporting Aluminum Roof

A NEW patent, "self-supporting" aluminum roof now being manufactured by the British firm of Aluminum Construction Company, Norfolk House, Strand, London, is claimed to have the same strength as a similar steel structure. It is intended primarily as a roof for oil or chemical storage tanks. An experimental model, 83 ft in diam with a 9-ft rise, was built at ground level and tested to a super load of 27 lb per sq ft. This was done by covering the dome with bricks and taking vertical deflection readings at nine points of the framework. In spite of the fact that mathematicians have never been able to discover the point where a uniform spherical shell becomes unstable under uniform pressure, preconstruction theoretical computations were vindicated in the practical test.

The new roof is made of extruded aluminum tubes, $2^1/_2 \times 2^1/_2$ in. outside, by $2^1/_8 \times 2^1/_8$ in. inside, curved to a radius of 100 ft and forming transverse ribs at intervals of 5 ft. Aluminum sheet is riveted to the structure, and the joints may be welded if necessary to render the whole airtight. Six men can erect the framework and weld all shoes to the outer support ring in one day. Since, under symmetrical loading they support themselves by tensile and compressive stresses, aluminum roofs of this type are said to be capable of a span between 500 and 600 ft.

FIG. 6 (*left*) DETAIL OF THE BALL-AND-SOCKET TYPE SHOES FOR RIB ENDS

FIG. 7 (*right*) A TYPICAL CROSS-JOINT WHERE THE RIBS MEET THE OUTER SUPPORT RING

(The ball-and-socket-type shoes pictured here are of the type used for the first experimental structure when they were welded into position.)

FIG. 8 A DEFLECTION READING IS TAKEN BY VERNIER BENEATH THE EXPERIMENTAL ROOF

Radioactive Tracers

IN answer to numerous requests Arthur D. Little, Inc., has prepared a selected bibliography on industrial uses of radioactive materials, hoping that it will prove useful to many who wish to become familiar with the powerful new techniques now possible with radioactive isotopes.

There are two main fields of industrial use for radioactive isotopes, atomic tracing or detecting and as compact portable sources of radiation.

This 13-page bibliography gives general background references and survey articles of industrial application. The bibliography proper is classified under 10 specific fields of application: petroleum, mining and metallurgy, textiles, instruments, radiography, analysis, pharmaceutical, glass, radioisotope preparation, and miscellaneous industrial applications.

Readers may obtain this bibliography, without charge, by writing directly to Arthur D. Little, Inc., Cambridge 42, Mass.

Coal-Burning Gas Turbine

RECENT progress on the BCR project to develop coal-burning gas-turbine locomotives was outlined by K. A. Browne, research consultant, Chesapeake and Ohio Railway Company, during the 1949 annual meeting of Bituminous Coal Research, Inc., Columbus, Ohio.

Standing shop tests will be made upon completion of the gas turbines being constructed by the Allis-Chalmers Company and the Elliott Company for BCR. In the meantime, coal-combustion tests on the government-loaned Houdry gas-turbine unit and further performance tests on an ash-collection system developed during BCR research at Fontana, Calif., will be run, he said. Final locomotive design will be based on these tests.

In outlining specific progress during the past year on the Locomotive Development Committee program, Mr. Browne said that the durability of combustors has been improved substantially by structural modifications. Combustion efficiencies

of around 98 per cent are now being obtained, he said. Trouble encountered with slagging and burnout caused by afterburning in the separators has been corrected, with efficient removal of fly ash from the hot gas.

Mechanical pulverization of coal is now being employed. Two methods of feeding pulverized coal to the combustion chamber are being compared. They are, first, grinding and storing pulverized coal at atmospheric pressure and feeding from the storage tank; and, second, direct pulverized-coal feeding from a pressurized mechanical mill. First tests on a full-scale turbine will employ the atmospheric system, but all the equipment used will be suitable for operating the pressurized system as well, he said.

Although several years will be required to complete this development, the speaker indicated that progress has been normal for a project of this magnitude, and its completion will form a major engineering accomplishment.

In addition, Mr. Browne stated, the extensive outlet for coal that will develop in the stationary power field following a successful coal-burning gas-turbine locomotive will, in a large measure, offset the decrease in coal required by the railroads as they replace the older steam power.

Lightning Research

LIGHTNING of course can and does strike the same place more than once. In fact, in one year 50 strokes were recorded as hitting the Empire State Building in New York, N. Y., by the General Electric Company's high-voltage engineers in connection with man's continuing study of the natural forces that surround him. Now, 15,000,000-volt bolts of artificial lightning can be fired more than 50 ft through the air in the new G-E High Voltage Engineering Laboratory which opened recently in Pittsfield, Mass. This laboratory will aid in extending research of high-voltage phenomena such as corona, spark-over, dielectric breakdown, lightning, etc.

The new laboratory is currently being used to conduct basic research into the effects of lightning and other high-voltage electric discharges on power-transmission lines and to study means of protection from lightning. The ultimate purpose is the improvement of electric service during storms through the prevention of power interruptions by lightning, so that the greatest continuity of electric service can be rendered by the power companies at the least expense. It is also continually used to improve the quality of high-voltage apparatus at reduced cost. See frontispiece on page 636 of this issue.

FIG. 9 ARTIFICIAL-LIGHTNING DISCHARGE BETWEEN THE TOPS OF TWO IMPULSE GENERATORS
(Arc is about 50 ft long and measures about 30,000 amp.)

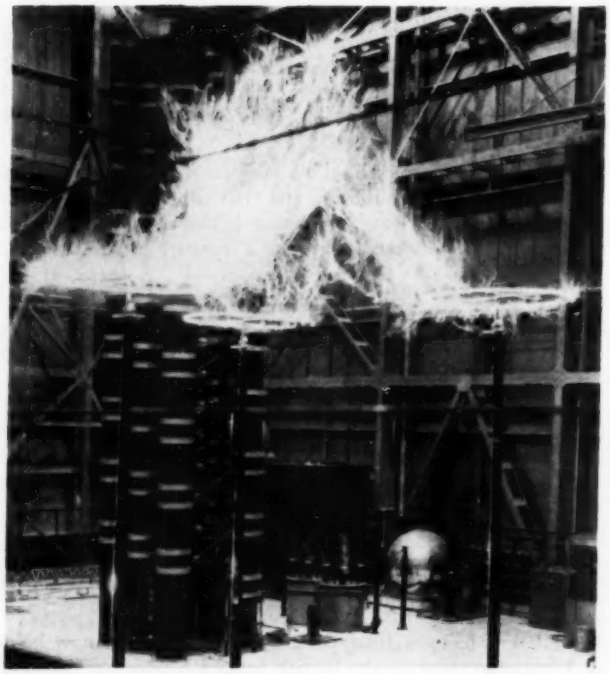

FIG. 10 1,000,000-VOLT 3-PHASE ALTERNATING-CURRENT ARC IN HIGH VOLTAGE HALL

The steel and concrete laboratory building, whose main demonstration hall has an 85-ft ceiling, was constructed at an approximate cost of more than $2,000,000, including equipment.

It is divided into four main parts: the High Voltage Hall, where the powerful surges of artificial lightning are made; the low bay building, where tests are run on various types of equipment; the controlled-temperature laboratory, in which high-voltage tests are conducted under varying degrees of temperature and humidity; and finally the offices, including a lecture room, five photographic darkrooms, chemical and physical laboratories, mechanical and electrical workshops, and other special test rooms.

High Voltage Hall, which measures some 165 ft in length and 85 ft in height, contains the two 7,500,000-volt impulse generators, the transformers, and controls used to produce the powerful strokes of lightning. No conventional windows are in the large room, since the research for the most part requires total darkness. Especially constructed louvers and ventilation systems keep fresh air coming into the room and keep out dust, harmful to the test equipment.

One of the giant generators, which is more than 50 ft high, is mounted on a low flat railway car so that it may be moved to an outdoor test area of some 7200 sq ft. The outdoor test area is used to conduct experiments on high-voltage transmission lines and on equipment too large to bring outside.

The work of the laboratory is divided into two main parts: (1) investigation of general interest, and (2) work of interest in the design of better electric equipment.

Under the first function of the laboratory come those studies which investigate the action of high-voltage discharges on

solids, gases, and liquids; study of lightning and its effects on electric apparatus, and transmission structures, and the development of new test methods.

As for work of interest to designers of electric apparatus, the laboratory will conduct studies of insulations, distribution of electric power and transformers, as well as other equipment, in order to make them safe from lightning.

The first G-E lightning investigations were begun by Charles P. Steinmetz, the late mathematical wizard, at Schenectady. They were continued under the late Frank W. Peek, Jr., who built the company's first 1,000,000-volt generator in Pittsfield, in 1922. Mr. Peek went on to develop the 5,000,000-volt and then the 10,000,000-volt generators. He also did much valuable pioneer work in the field of high-voltage power frequencies.

Dr. Karl B. McEachron succeeded Mr. Peek as engineer in charge of the high-voltage laboratory at Pittsfield, and directed the lightning studies G-E conducts on New York's Empire State Building, and the studies of lightning in the Pittsfield area. Mr. Julius Hagenguth succeeded Dr. McEachron as engineer of the high-voltage laboratory.

Many of the fundamentals of impulse testing on high-voltage equipment have been developed in the laboratories here since the first one was erected in 1913.

However, though much progress has been made, high-voltage research is just beginning. The greater space of the new laboratory will allow engineers to experiment at higher voltages on larger equipment, including transformers, lightning arresters, capacitors, and bushings.

Heat-Pump Data

HEAT extracted from well water has been used successfully to heat a 12-story office building in Portland, during one of Oregon's worst winters, at less than one half the cost of coal-heating, it was reported at the 1949 semi-annual meeting of the American Society of Heating and Ventilating Engineers in Minneapolis, Minn., recently.

This was accomplished by means of a heat pump installed in the Equitable Building, said to be the largest heat-pump system in an office building in this country at present. Complete data on the operation of the heat-pump plant was kept for a year by J. Donald Kroeker, head of the firm of consulting engineers bearing his name; Ray C. Chewning, a member of Mr. Kroeker's firm; and Charles E. Graham, building engineer of the Equitable Building.

The heat pump, a device in very limited use, picks up heat at a lower temperature (from a source such as the earth, water, or air) and delivers it at a higher temperature. The heat pump "steps up" the temperature by compressing a gas when it is returned after circulating through coils in contact with the heat source (in this case, well water).

It can be installed so that it may be reversed in the summer to cool a house or other building in much the same manner that a refrigerator cools food. However, operating details of the heating phase only were given by the authors.

They told the ASHVE that after heating the building through the winter of 1948–1949, "probably one of the most rigorous Oregon has experienced," their carefully kept calculations pointed to a normal heating cost "materially less" than 46 cents per million Btu. This was less than the original estimated cost at the time the heat pump was installed.

Roughly, this comes down to 22,000 heat units for one cent. Comparative figures are 10,000 units for a penny's worth of coal and 8000 units for one cent's worth of oil.

The "coefficient of performance" or ratio of the heat obtained in return for the amount of work performed by the electrically operated heat pump, was found by the authors to be 19.2. This, they pointed out, was based on the work of the compressors but not the auxiliary pumps, and included the by-product heat in the building from occupants, electrical fixtures, etc.

Mr. Kroeker and his co-authors emphasized the importance of applying the best possible automatic control in the interest of operating economy, but, they declared, the operator of the equipment should be "above the average operating personnel" and should have an "analytical mind which can sort out and properly correlate the information" which the instruments give.

An intelligent operator properly trained can save $150 to $250 in a month in operating costs alone in a system the size of that in the Equitable Building, they said.

The Equitable Building is a 12-story rental office building with a plan area 100 ft × 200 ft for the basement, first and second floors; 60 ft × 200 ft for the third through the 12th floors; a 13th set-back floor approximately one half the latter area; and two penthouse levels.

The building is of reinforced-concrete construction, with aluminum facing. The double-pane windows extend from column to column thereby taking up almost the entire facade area. The exterior pane is made of heat-absorbing glass, which reduces the heat loss due to glass by 50 per cent and the heat gain by 40 per cent.

The authors declared that the heat source adopted in the use of a heat pump in a large building would "normally" be well or surface water. They warned, however, that often such water is corrosive and advised that water analyses should be made in all cases to determine the required treatment for the water.

Necessity of treatment should be determined prior to application of the particular design of heat pump, they said, since in some cases the cost may be so high as to render the application of a heat pump uneconomical.

Toxic Eye Hazards

CHEMICAL eye injuries are assuming a prominent position in the field of industrial ophthalmology. New chemicals are being added continuously to the already long list essential to modern production. Even before full information is available on the names and the effects of those already in use, we are faced with new types of damage. With this in mind, the National Society for the Prevention of Blindness announces the publication of a new manual, "Toxic Eye Hazards," dealing with various safeguards against the many chemicals now used in industrial processes.

The manual is the result of research undertaken by the Joint Committee on Industrial Ophthalmology of the American Medical Association and the American Academy of Ophthalmology and Otolaryngology on the effects of various chemicals on the eyes.

Types of protective equipment best suited to specific hazards and a standard program for eye safety from chemical exposure are covered in sections of the book contributed by experts in the fields of industrial ophthalmology and safety engineering. These recommendations are based on actual studies of conditions in a chemical-manufacturing center of the country. In this group of plants, over a two-year period, eye injuries comprised 25 per cent of all injuries to employees.

A unique and valuable feature of the 102-page manual are the tables of toxic chemicals and their effects on the eyes, classified under organic and inorganic compounds, detergents, and soaps. Another section deals with specific first-aid procedures for chemical eye injuries. Many charts and illustrations, and a

comprehensive list of references for additional reading are included.

Designed both for laymen and professional personnel, the manual will be useful to anyone dealing with industrial eye injuries and problems of protection.

Copies of Toxic Eye Hazards may be ordered from the National Society for the Prevention of Blindness, 1790 Broadway, New York 19, N. Y., at $1 per copy.

Archaeology

A RUBBER molding material made by American Anode Inc. of Akron, Ohio, is a modern tool of archaeological research. This was disclosed recently when Dr. George G. Cameron, archaeologist, returned from a historic expedition to Iran where he copied, in a rubber mold, the ancient rock sculptured panel known as the Behistun relief and inscription. Plaster reproductions of this remarkable monument, often referred to as the "Rosetta Stone of Western Asia," will soon be made at the University of Michigan where Dr. Cameron heads the Department of Near Eastern Studies. These will be sent to museums both in this country and abroad for exhibition.

The noted relief and inscription is located 100 ft above a sheer vertical wall and 300 ft above the Baghdad-Teheran Road in Iran and was carved some time between 520 and 512 B. C. It portrays Darius, King of Persia, and some of his enemies whom he was compelled to defeat in battle before he could extend his empire and begin his war with Greece. Beneath the relief proper are carved $7\frac{1}{2}$ columns of cuneiform (wedge-shaped) inscriptions, in Old Persian, and Elamite, an ancient language mentioned in the biblical book of Esther. To the left of the relief panel, on a large overhanging rock, are two columns inscribed in ancient Babylonian. The three versions relate the same story about Darius, how he outwitted his enemies, and finally became King of Persia. First examined in 1835 by a British adventurer, Sir Henry Rawlinson, and again in 1904 by an expedition from the British Museum, the three versions have been the key to the decipherment of all cuneiform inscriptions written in ancient times when all writing was done on stone or clay.

In addition to these three versions, there exist four other inscribed columns to the right of the relief panel which were never read or copied because of their inaccessibility, until Dr.

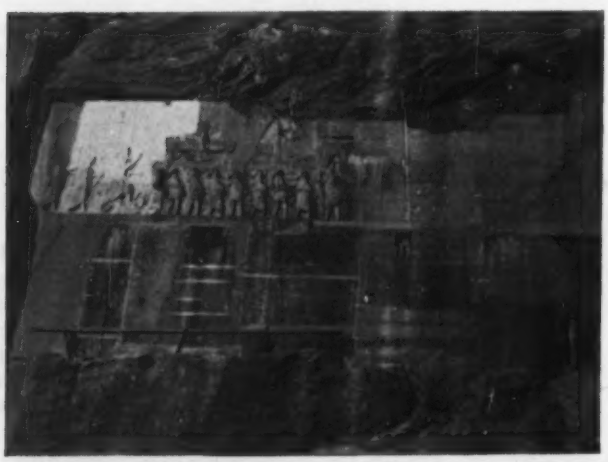

FIG. 11 PART OF RELIEF, WITH AN INSCRIPTION ABOVE IT, IS HERE COVERED WITH LATEX MUSEUM COMPOUND, IN WHITE

To the right of the relief lie four columns of inscriptions which no one had ever before been able to copy.)

FIG. 12 SCAFFOLDING HERE WAS NEARLY UP TO THE TOP OF RELIEF

(Beneath are a few of the enemies whom Darius, King of Persia, had to conquer before he made himself secure upon the throne shortly after 522 B. C. On the right are the four columns hitherto uncopied. In the upper left is the winged figure of the god Ahuramazda, who taught Darius "never to tell a lie.")

Cameron succeeded in making the first accurate copy with the aid of the latex museum molding compound.

Thellatex compound, used extensively during the war in the preparation of relief maps, is a clear compound, tending toward the opaque, with excellent aging characteristics and storage stability. It is supplied in concentrated form so that it may be applied either by brushing, spraying, or dipping. Dr. Cameron used the brush technique, decreasing the viscosity of the latex with additions of ammonia. To cover the various inscriptions and relief proper that he wished to reproduce, 30 gal of latex and two quarts of ammonia were required.

Dr. Cameron's objectives were to copy the unread inscriptions, to re-examine all doubtful passages in those which had already been read, to determine how the ancient Persians had actually constructed this monument to Darius, and to bring back a cast of the relief itself.

After his arrival at the Behistun monument, Dr. Cameron, with the assistance of a corps of workmen supplied by the Anglo-Iranian Oil Company, had lowered into position a 16-ft scaffold—his working area for the next three weeks in copying the relief and inscription.

Five coats of compound were applied to the relief and inscription in checkerboard effect. While the first coat was being applied to one section of the inscription, the third, fourth, or fifth coats were being applied to other sections, so there was no loss of time during the drying phase.

A thin first coat was applied and then allowed to dry thoroughly for one hour. The second coat was heavier, over which

a thin strip of gauze was then placed. A third coat was placed over the gauze and allowed to dry for approximately three hours. The fourth coat, very heavy, was covered by a cotton-type material known in Iran as "tanzif." The fifth coat was then applied and allowed to dry for at least 24 hours. After complete drying, hampered often by heavy rains, the latex mold was then pulled off in rectangular sections from the face of the monument, and rolled.

The riddle of how the inscription was carved in the first place without cables or scaffolding by the ancient sculptors was also solved. A secret stairway had been carved into the side of the cliff and then scraped away, giving no one an opportunity to deface the work.

Airplane Testing

PRODUCTION models of the Grumman Panther—new carrier-based fighter said to be equipped with the most powerful production jet engine in the world—are being tested in a unique test setup developed by the Grumman Aircraft Engineering Corporation.

The F9F-2 or F9F-3 under test is stationed on a specially constructed flexural-suspension platform, and operated as if in free flight, with a force-measurement system bearing its full thrust and compensating with compressed air to hold the craft motionless.

By this means the static thrust of the airplane, which varies from that of the jet engine alone, can be measured precisely as a unit. Also, the novel test procedure permits the internal thrust-measuring instrumentation to be check-calibrated.

Operating the airplanes at various RPM settings enables the engineers to plot curves of the effective thrust of the craft as related to engine speed. Tail-pipe temperatures, engine rpm, duct-inlet static pressure, and other aspects of performance are precisely measured and/or controlled.

A pneumatic-balance force meter, or load cell, known as the "ThrusTorq," made by Hagen Corporation, Pittsburgh, Pa., is the device in the system used to measure the jet-plane thrust. Its principal feature is a nonmetallic flexible diaphragm and poppet valve. The thrust of the airplane is applied to one side of the diaphragm, and air pressure—just sufficient to balance the thrust—to the other. Thus the air pressure required to obtain a balance is a direct measure of the thrust. This balancing pressure is continuously and automatically metered into the diaphragm chamber by the sensitive poppet valve, which itself is controlled by the position of the diaphragm.

The test is conducted as follows: The airplane is positioned onto the platform, and chocked firmly. Nose-wheel oleo is bled down to bring the thrust line within plus or minus 1 deg of horizontal. The airplane is backed out until a zero-adjusting bolt on the platform makes contact with the diaphragm of the ThrusTorq. With air pressure turned on the Thrus Torq, any desired "tare" reading or "preload" then is easily made, and the bolt locked in place. This adjustment nullifies the effects of wind and temperature on the gage readings.

When the engine is turning over, any desired power settings may be made, and resultant thrust measured. An electric tachometer measures engine speeds, which in these tests normally range from 4000 or 5000 up to 12000 rpm.

A 0 to 110-psi precision-type gage is employed to indicate the output pressure, thereby indicating the thrust developed by the engine. Compressed air for this unit is supplied from a standard compressed-air bottle, equipped with regulator, through a reducing valve, air filter, and air drier. A standard needle valve serves as a blowdown valve when the pneumatic force-measuring system is exhausted and secured at the end of a test run.

Regular crews handle the aircraft on test. Flight-test engineers planned the force-measuring systems and operating procedure, with flight development personnel and tool-engineering men in charge of operations, and flight-test engineers supervising handling of the test airplanes.

Rapid Selector

A FUNDAMENTAL advance in the organization, storage, and dissemination of knowledge is foreseen in an "electronic brain" machine developed jointly by the U. S. Department of Commerce and the U. S. Department of Agriculture.

The machine stores vast amounts of scientific information in its system, automatically "pores" over it, selects what is sought after by its operator, and then hands him copies of what he wants.

Known as the Rapid Selector, the device was developed from principles originated before the war by Dr. Vannevar Bush, then at the Massachusetts Institute of Technology.

The selector makes use of standard 35-mm motion-picture films on each reel of which can be "stored" the contents of almost 500,000 conventional library cards.

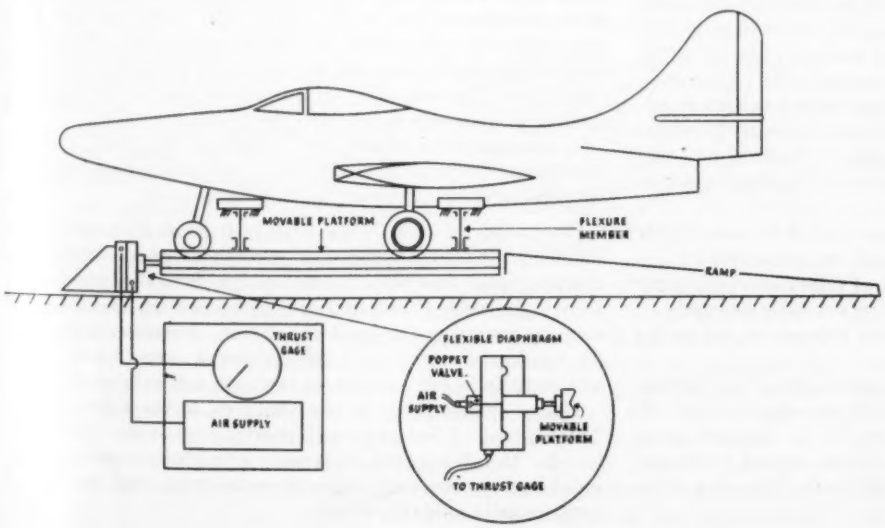

FIG. 13 SCHEMATIC VIEW OF AIRCRAFT THRUST STAND, SHOWING INTERRELATIONSHIP OF AIRPLANE ON TEST, FLEXURAL-SUSPENSION PLATFORM, AND THE THRUSTORQ, AND OTHER COMPONENTS OF THE THRUST-MEASURING SYSTEM

When the information is microfilmed, a predetermined code pattern, consisting of black and white squares, is simultaneously printed on the film indicating the subject to which the information relates.

The operator of the machine, wishing to obtain everything the selector possesses on a particular subject, places a master key card in the mechanism. The selector's photoelectric eyes then scan the film at a rate of more than 60,000 subjects a minute, automatically select the desired frames, and copy them on a separate film through the use of high-speed photoflash techniques.

This development is of inestimable value in research where all references in a particular field must be thoroughly checked before undertaking new work. Depending on the subject matter and the extensiveness of previous researches, the hunt for references varies from days to weeks.

As an example of how the new machine might eliminate this burdensome time factor, an estimate has been made indicating that it would take the Rapid Selector only about fifteen minutes to review all the entries that have appeared in the last thirty years in *Chemical Abstracts*, a standard guide to all chemical research. This of course presupposes that the abstracts have first been transferred to microfilm and properly coded with light patterns for use in the machine.

The selector, which can potentially be coded for ten million different subjects, uses a principle similar to photoelectric cells in door-opening devices. In such devices, when a person's body cuts off the beam of light, the photoelectric relay opens the door. In a like manner, the selector scans the patterns of light and dark accompanying each film frame "looking" for a particular pattern to match the master key inserted in the machine. When the two coincide, a flashlamp is fired photographing the frame passing through the scanning area at that instant.

This flash results in a copy of the item of information desired by the operator. When a complete reel has passed through the machine, the researcher has a complete and accurate bibliography of the subject in a minimum of time.

A repeating flashlamp is used similar to those increasingly in favor by photographers because of its brilliant instantaneous beam which lasts only two millionths of a second, thereby "stopping" the swiftest motion for the camera.

Before the machine could be put into operation a number of troublesome details had to be worked out. For example, as long as the abstracts selected by the machine for photographing were spaced a few inches apart, the machine photographed them at full speed. However, if the frames to be photographed were too close together, the mechanism could not move an additional frame of unexposed film into position quickly enough to photograph the second frame. The difficulty was solved by including a second electric-eye scanner which anticipates the approach of any frame which is too close to be photographed at high speed. The device slows down the whole machine sufficiently to enable the unexposed film to be moved in time to make the photograph. After the second picture is taken the machine resumes its normal speed.

The machine, it is reported, can be applied to many other uses besides scientific research. It is said to be suitable for any organization which has vast amounts of information requiring compact storage and yet which must be available promptly.

The basic features of the machine are unpatented and in the public domain.

A report describing the Rapid Selector in detail and accompanied by illustrations (PB 97535, $2.50 per copy) is available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Orders should be accompanied by check or money order payable to the Treasurer of the United States.

Original drawings of mechanical details for the selector are available for inspection at the Office of Technical Services in Washington, D. C.

Tropical Hardwood

AN answer to the world's growing shortage of high-grade hardwood has been provided by a two-year research program at Yale University.

The Yale School of Forestry has found that many species of tropical hardwood exhibit economic potentialities superior to a number of timbers now in common use. These tropical sources have long been ignored.

The results of this research were announced recently by Frederick F. Wangaard, associate professor of Forest Products at Yale. Mr. Wangaard spoke at the Symposium on Woods in the National Academy of Sciences, Washington, D. C.

Studies were initiated in April, 1947, through the office of Naval Research, to determine the basic characteristics of a selected group of tropical American timbers, and to evaluate each species with regard to its potentialities for specific uses.

Although immediate large-scale commercial acceptance is not anticipated on the basis of these tests, data of this type should serve to arouse the interest of potential producers and consumers. These data should also stimulate further tests and trials to demonstrate the performance of the wood in actual use, Mr. Wangaard stated.

He said that this new information is calculated to supplement native U. S. species, thereby taking the pressure off this country's forests and presenting the opportunity for replenishing the woodlands. In addition, he pointed out that the study report should give new emphasis for maintaining wood markets.

In scientifically evaluating the properties of tropical woods, tests were conducted upon the mechanical properties, or strength of the woods; the density or weight; the dimensional stability, decay resistance, seasoning characteristics, and other properties. This first accounting covers 25 separate wood species.

The woods were evaluated for practical use in boat building, decking, planking, frames, keels; construction timbers; exterior use, such as home building; frame construction; furniture; instruments; marine piling; patterns for the casting of metals; veneer and plywood.

Accurate identification of all test material was provided through the selection of representative standing trees in the forest by botanists, foresters, or lumbermen. Herbarium specimens consisting of leaves, flowers, or fruit from the same tree were collected to document the field identification. From each tree, an 8-ft log representing the upper half of the first 16-ft log taken above the butt was marked and shipped to New Haven, Conn., where it was sawed into test planks.

In tabulating the results, Mr. Wangaard presented statistics illustrating the tropical woods which have been found suitable for popular uses. They are, in part, as follows:

Eleven species with the qualities of freedom from warp, low shrinkage, hardness, abrasion resistance, good weathering characteristics, low moisture absorption, durability and moderate weight, such as required in marine decking; hardness and abrasion resistance and good appearance, characteristics needed for residential, store, and office flooring were found in 17; and 20 varieties are suitable for furniture and cabinet work.

Under sponsorship of the Office of Naval Research, the Yale School of Forestry will continue its study of tropical woods, Mr. Wangaard declared. The project can continue indefinitely, constantly opening new areas and sources of commercially valuable woods.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Applied Mechanics

Vibration of Multifrequency Systems During Acceleration Through Critcial Speeds, by G. D. McCann, Jr., Mem. ASME, and R. R. Bennett, California Institute of Technology, Pasadena, Calif. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-10** (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents generalized solutions for the response of a linear two-degree-of-freedom system excited by a single constant-magnitude sinusoidal force whose frequency varies uniformly with time. These solutions were obtained with the Cal Tech "electric-analog computer" which is described briefly since it has wide application to problems of this type.

Holzer Method for Forced-Damped Torsional Vibrations, by T. W. Spaetgens, Vivian Diesels and Munitions, Ltd., Vancouver, B. C. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-12** (in type; to be published in the *Journal of Applied Mechanics*).

The forced and resonant-vibration characteristics of a torsional system are easily enough determined by the well-known Holzer methods, in the case where the only major damping influences available in the system are those of the prime mover itself, or of the propeller, in the case of a propeller propulsion system. Where a damper exists within the system, the classic solution confines itself to the determination of the *resonant*-vibration characteristics under optimum damping conditions, and utilizes the principle of energy balance in conjunction with an equivalent system. The problem of *forced* vibration in a system having a damper is not susceptible, however, to such simple treatment regardless of whether or not the damping is optimum. This paper outlines an exact method, whereby both the forced and the resonant-vibration characteristics of a viscously damped system may be calculated for any existing damping condition, optimum or otherwise, and which utilizes the ever-popular Holzer form.

Analysis of a Single Stiffener on an Infinite Sheet, by S. U. Benscoter, NACA, Langley Field, Va. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-13** (in type; to be published in the *Journal of Applied Mechanics*).

The use of stiffened-sheet construction in aircraft design has brought about the study of many problems in mechanics in which concentrated loads are introduced into stiffeners and transferred to the sheet. In the present paper a basic problem of this type is considered. A single stiffener of finite length is assumed to be attached to a sheet of infinite extent. A concentrated force is applied to the stiffener at each end. Any given problem may be divided into symmetrical and antisymmetrical parts. The physical condition that governs the problem is that the axial strain in the stiffener must be equal to the normal strain in the sheet at all points along the stiffener. In order to formulate the solution, it is necessary to employ an influence function for the strain in the sheet. This function is known from the classical theory of elasticity. The solution is found to be governed by an integral equation which has the same form as the equation which governs spanwise air-load distribution on an airplane wing. Hence a number of mathematical methods are known for solving the equation. A numerical example is presented.

Effect of Imperfections on Buckling of Thin Cylinders and Columns Under Axial Compression, by L. H. Donnell, Mem. ASME, Illinois Institute of Technology, Chicago, Ill., and C. C. Wan, Jun. ASME, Chance Vought Aircraft, Dallas, Texas. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-14** (in type; to be published in the *Journal of Applied Mechanics*).

Von Kármán and Tsien have shown that under elastic conditions the resistance of perfect thin cylinders subjected to axial compression drops precipitously after buckling. It is considered that this indicates that this type of buckling is very sensitive to imperfections or disturbances. In this paper the effects of certain imperfections of shape (assumed to be equivalent to all the actual defects or disturbances combined) are studied by the large deflection shell theory developed in a previous paper.

It is found that two types of buckling failure may occur. One is of a purely elastic type which occurs when the peak of the average stress versus average strain curve is reached, while the other type is precipitated by yielding, which for thicker cylinders or lower-yield material may occur before such a peak is reached. Curves are derived giving the dependence of each type of failure upon the dimensions and elastic and yield properties of the specimen, and also upon an "unevenness factor" U which determines the magnitude of the initial imperfection and is assumed to depend on the method of fabrication. The relations derived are in line with test results, and similar studies of the buckling of struts indicate that the magnitude of the initial imper-

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fections, which have to be assumed to explain test strengths, are reasonable.

Deflections and Moments Due to a Concentrated Load on a Cantilever Plate of Infinite Length, by T. J. Jaramillo, Armour Research Foundation, Chicago, Ill. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-15** (in type; to be published in the *Journal of Applied Mechanics*).

This paper contains an exact solution in terms of improper integrals for the deflections and moments due to a transverse concentrated load acting at an arbitrary point of an infinitely long cantilever plate of constant width and thickness. The solution is transformed into series form by means of contour integration, and is illustrated by numerical examples. In particular, comparisons are made with the known solution for the special case where the load is applied at the free edge of the plate. The results obtained are of practical significance in connection with the design of certain types of monorail cranes.

A Comparative Study of Some Variational Principles in the Theory of Plasticity, by Rodney Hill, British Iron and Steel Research Association, Sheffield, England. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-16** (in type; to be published in the *Journal of Applied Mechanics*).

The variational principle of Markov for velocity distributions in a plastic state is extended to a work-hardening material and to more general boundary conditions. A relationship is shown to exist between Markov's principle and the maximum work principle of Hill.

On One-Term Approximations of Forced Nonharmonic Vibrations, by G. Schwesinger, Signal Corps Engineering Laboratories, Fort Monmouth, N. J. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-17** (in type; to be published in the *Journal of Applied Mechanics*).

Steady forced vibrations of harmonically excited nonlinear systems deviate from a sinusoidal wave form, the magnitude of the deviation depending upon the frequency of the exciting force and the nature of the system concerned. Approximations by simple harmonic solutions suggested so far are either restricted to special vibration problems or generally fail to provide the desired accuracy without giving account of the errors committed. An improved general method is proposed and demonstrated, yielding the best accuracy attainable with harmonic solutions. This method, furthermore, gives the approximate root mean square of the error and thus allows for establishing dependable limits for its applicability.

Introduction to the Comprex, by F. W. Barry, Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-18** (in type; to be published in the *Journal of Applied Mechanics*).

This paper describes the construction and operation of a comprex, or pressure exchanger, together with its application to a gas-turbine cycle. A simple analysis is also developed, which is intended to indicate the performance characteristics of a comprex. This analysis shows that the pressure ratio, relative gas flow, and the ratio of the temperature of the leaving gas to that of the entering air are all functions of scavenging velocity and of the nature of the compression and expansion processes (as is shown graphically). Some irreversibility is found to be essential to the useful operation of a comprex. Finally, formulas for the major dimensions of a comprex are presented.

A Force Applied in the Median Plane at the Center of a Circular Insert in a Plate, by S. J. Dokos, Armour Research Foundation, Chicago, Ill. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-19** (in type; to be published in the *Journal of Applied Mechanics*).

The problem to be considered in this paper is the determination of the state of stress in a plate containing a right, circular, cylindrical hole filled with a material of different elastic properties, subjected to a central concentrated force in the median plane of the plate. A special solution is also presented in which the modulus of rigidity of the insert is allowed to approach infinity such that no deformation occurs.

Influence of the Dimensional Factors on Mode of Yielding and Fracture in Medium-Carbon Steel—II, by Julius Miklowitz, University of Michigan, Ann Arbor, Mich. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-20** (in type; to be published in the *Journal of Applied Mechanics*).

Test results show an increase in axial strain, average true stress, and maximum true stress at the minimum section of the neck of a round tension bar at fracture when the size of the bar is decreased. An explanation is given for this size effect on the axial strain. It suggests that the restraint on the flowing material at the heart of the neck, created by lateral stresses induced by the adjacent stagnant material is dependent upon the diameter of the stagnant material; hence the bar diameter. Some metallurgical variations in the data are analyzed and discussed.

Use of an Optical Property of Glycerine-Water Solutions to Study Viscous Fluid-Flow Problems, by W. W. Hagerty, Jun. ASME, University of Michigan, Ann Arbor, Mich. 1949 ASME Applied Mechanics Division Conference paper No. **49—APM-21** (in type; to be published in the *Journal of Applied Mechanics*).

It is a property of certain concentrations of glycerine-water solutions, when in a state of steady flow, in that the planes of equal shear in the liquid become visible in ordinary light, if viewed along a path tangent to the shear plane. This phenomenon has been used successfully to study a fluid-flow problem at the University of Michigan. The nature and scope of application of this optical property is currently being studied further. This report gives details of what may prove to be a useful tool in certain phases of experimental fluid-flow problems.

Stress Studies on Piping Expansion Bellows, by F. J. Feely, Jr., and W. M. Goryl, Jun. ASME, Standard Oil Development Company, Elizabeth, N. J. 1949 Applied Mechanics Division Conference paper No. **49—APM-22** (in type; to be published in the *Journal of Applied Mechanics*)

As a result of numerous and costly failures of the stainless-steel bellows used to take up thermal expansion in the piping of petroleum and chemical-processing equipment, a basis has been developed for designing these bellows to operate within reasonable stresses. A formula has been derived to show the total stress induced in the material as a result of the combined effects of pressure and movement. The validity of the approximations used in this formula has been verified by laboratory strain-gage measurements on an experimental bellows. A relationship between several variables in the design of the disks has also been determined and serves as a basis for dimensioning them to achieve the most

economical proportions. When this relationship is satisfied, the maximum permissible movement per disk can be obtained. This is shown graphically. Several supplementary formulas are given for determining bellows characteristics which may affect the design of adjacent piping. The problem of designing an expansion joint for high-pressure service is discussed briefly, and more preliminary laboratory data are presented on a commercial joint of this type.

On Plastic Flow and Vibrations, by C. J. Thorne, visiting associate professor of engineering, University of California, Los Angeles, Calif. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-23** (in type; to be published in the *Journal of Applied Mechanics*).

A general solution is given for the behavior in the linear case of a mechanical model proposed and used by Henry Eyring and others. Four examples are worked in detail. In particular, the steady-state solution for the deflection in periodic vibrations is given in terms of the material constants for any frequency. The transients are given in detail for the three possible cases, and inequalities are given to determine which case a particular problem is.

The Behavior of Long Beams Under Impact Loading, by P. E. Duwez, D. S. Clark, Mem. ASME, and H. F. Bohnenblust, California Institute of Technology, Pasadena, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-1** (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents the results of a theoretical and experimental investigation of the plastic deformation of long beams which are subjected to a concentrated transverse impact of constant velocity. In the theoretical analysis, the beam is supposed to be of infinite length, and plane cross sections are assumed to remain plane. The bending moment is assumed to depend on the curvature according to a function that is obtained from the stress-strain curve of the material. The theory neglects both the lateral displacement of the cross sections against each other due to the shearing force and the rotary kinetic energy of the motion of the beam. The theory shows that a strain is not propagated along a beam at constant velocity, as in the case of longitudinal impact. The strain depends on the ratio between the square of the distance from the point of impact and the time. This is correct regardless of the shape of the moment-curvature curve. If certain approximations are applied to the bending moment-curvature curve, the theory provides a method of computing the deflection curve of a beam at any instant during impact. An experimental study has been made in which the deflection curves of long simply supported beams have been obtained during impact. The deflection characteristics of a cold-rolled steel and an annealed-copper beam have been computed by approximating the bending moment-curvature curves. It is shown that for materials such as cold-rolled low-carbon steel, for which plastic deflection is localized at the point of impact, the observed deflection curve is closely approximated by computing a curve based on the assumption that the beam remains elastic. For a soft material like annealed copper, plastic deformation extends over a relatively large distance from the point of impact and, taking plastic deformation into account, a satisfactory agreement is obtained between theory and experimental results.

Beam-Vibration Analysis With the Electric-Analog Computer, by G. D. McCann, Mem. ASME, and R. H. MacNeal, California Institute of Technology, Pasadena, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-3** (in type; to be published in the *Journal of Applied Mechanics*).

The authors have developed a true dynamic analogy which has been used with the Cal Tech electric-analog computer for the rapid and accurate solution of both steady-state and transient beam problems. This analogy has been found well-suited to the study of beams having several coupled degrees of freedom, including torsion, simple bending, and bending in a plane. Damping and effects such as rotary inertia may be handled readily. The analogy may also be used in the study of systems involving combined beams and "lumped-constant" elements.

Transverse Vibration of a Two-Span Beam Under Action of a Moving Constant Force, by R. S. Ayre, George Ford, and L. S. Jacobsen, Mem. ASME, Stanford University, Stanford University, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-4** (in type; to be published in the *Journal of Applied Mechanics*).

The problem relates to the transient vibration of a symmetrical, continuous, simply supported-two-span beam which is traversed by a constant force moving with constant velocity. The beam is of slender proportions, flexure alone being considered. Damping is zero and there is no mass associated with the moving force. Exact theoretical solutions for bending stress have been derived in general form. They consist of three infinite series, each related to one of three time eras as follows: (*a*) Where force is crossing first span; (*b*) is crossing second span; (*c*) has left the beam. Each term of a series is related to a natural mode of vibration. Quantitative theoretical studies show the variation in individual terms of the series, and also in summations of the first five terms, as the traversing velocity is varied. A mechanical model with electrical recording of stress was employed to obtain a more complete quantitative solution than was feasible analytically. The agreement between theory and experiment was reasonably good. Large magnifications of stress (of the order of 2.5) were found in the neighborhood of resonance with the fundamental mode.

Free Periodic Motions of an Undamped Two-Degree-of-Freedom Oscillatory System With Nonlinear Unsymmetrical Elasticity, by Walter W. Soroka, University of California, Berkeley, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-6** (in type; to be published in the *Journal of Applied Mechanics*).

Precise solutions are presented for a two-degree-of-freedom oscillatory system containing a preset spring. Such a system is characteristic of an aircraft propeller-engine-supercharger installation. The periodic free motions obtained indicate the possibility of highly unconventional motions when the nonlinearity is pronounced, motions which may be easily overlooked in the usual approximate treatment of nonlinear systems. The results presented in this paper show that one mass may oscillate several times while the other mass is going through one oscillation. The ratio of oscillations of one mass with respect to the other changes with amplitude.

By considering the load-deflection curve for the nonlinear spring to be a broken line, periodic motions may be obtained to any desired degree of precision by combining conventional general solutions for two-degree-of-freedom linear systems.

Railroad Trucks

Truck Riding Comfort, by K. F. Nystrom, Fellow ASME, Milwaukee, St. Paul and Pacific Railroad Company. 1948 ASME Semi-Annual Meeting paper No. **48—SA-48** (in type; published in Trans. ASME, April, 1949, p. 201).

This paper points out that in creating

luxurious passenger cars, economical limits have been exceeded by introducing costly, complicated, and over-engineered appurtenances. The same criticism applies to truck design. Excessive weight and complications militate against long life of truck and track, and maintenance costs are high. The paper analyzes the components of the truck and points out where improvements can be made, finally suggesting the characteristics of the passenger-car truck of the future.

Gas-Turbine Power

The Gas-Turbine Regenerator—The Use of Compact Heat-Transfer Surfaces, by A. L. London, Mem. ASME, and W. M. Kays, Jun. ASME, Stanford University, Stanford, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-9** (mimeographed).

This paper illustrates the application of high-rating compact surfaces of the plate-fin type to the regenerator design problem for four typical gas-turbine cycles. Comparisons are made with designs employing circular tube surfaces $1^1/_4$ in. in diam.

The high-efficiency gas-turbine plant requires a design philosophy of close attention to details in all respects. This insistence on optimum design is mandatory because operation at temperatures approaching metallurgical limits, large specific-flow rates (lb per shp-hr) of the working substance, the high "back-work" input to the compressors multiplying the cost of flow friction power, are all coupled with the requirement of a compact machinery arrangement. The requirement of compactness is a major consideration in the transportation application of the gas-turbine plant if its basically lightweight aspect is to be capitalized upon.

During the present pioneering development of the gas-turbine system, relatively little attention has been devoted to the heat-exchanger components—primarily the regenerator. However, for a gas-turbine plant having a specific fuel consumption over a fairly wide load range comparable to that of a steam plant, a regenerator of considerable specific transfer area is required.

This paper emphasizes the ultimate necessity of the development of types of heat-transfer surfaces for the regenerator having substantially higher area-to-volume ratio characteristics than conventionally used boiler and condenser tube banks. Attention is directed to the use of either small circular or flat tube surfaces of the order of $^1/_4$-in. hydraulic diameter, or else extended surfaces. In the latter case it will be necessary to have a type of construction allowing extended area on both the hot and cold gas sides since each heat-transfer film resistance is of the same order of magnitude, and the coefficients are sufficiently low to permit satisfactorily high-temperature effectiveness for the fin surfaces.

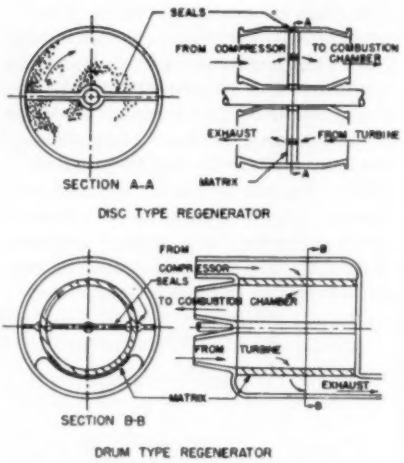
To illustrate the wide variance in inherent compactness of different surfaces, a comparison between the area-to-volume ratio of several types of surfaces was made. The 10:1 difference for plate-fin surfaces as compared to 1-in-diam tubes and a 2.3:1 comparison even with $^1/_4$-in. tubes resulted.

Some of the conclusions are as follows: (1) In order that circular-tube surfaces can become competitive with extended surfaces of the plate-fin type with respect to volume, weight, and shape, it is necessary to resort to small diameters of the order of $^1/_4$ in. (2) Units fabricated from small-diameter tubular surfaces in high-alloy material will probably have a higher material and labor cost than the plate-fin surface, provided methods of furnace brazing fabrication can be developed for the latter. (3) If compact regenerators have to be realized, mechanical-cleaning methods cannot be employed. In this respect the plate-fin type of surface appears to be cleanable and will probably show less tendency to foul as compared to $^1/_4$-in. tube or similar surfaces.

Design of Heat Exchangers for the Regenerative-Cycle Aircraft-Turboprop Engine, by F. E. Romie, Jun. ASME, A. G. Guibert, and C. D. Coulbert, University of California, Los Angeles, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-18** (mimeographed).

The purpose of this paper is to show, by specific examples, some of the problems involved in the application of the regenerative cycle to the aircraft turboprop engine and to give, for two hypothetical engines, a general idea of the sizes and weights of exchanger cores necessary for the attainment of various engine thermal efficiencies. Because of the large number of parameters which enter into the final selection of heat exchangers for the regenerative-cycle aircraft-turboprop engine, only a limited number of examples, arbitrarily chosen, are used to illustrate the paper.

The analysis is similar to the analysis made for stationary engines inasmuch as, for purposes of simplification, the effects of ram and jet have been omitted from the analysis. However, the addition of regeneration to the aircraft power plant is most easily justified for long-range relatively low-speed airplanes for which the effects of ram and jet do not have an important influence on the exchanger design. Thus it is probable that the conclusions which result from this analysis will be valid for most applications of the regenerative cycle to the aircraft turboprop engine.



DIAGRAMMATIC SKETCHES OF TYPICAL REGENERATIVE HEAT EXCHANGERS FOR GAS TURBINES

The heat exchanger used for regeneration may be of either the familiar recuperative type or the rotating regenerative type in which heat is alternately transferred to and from the heat-exchanger core as the hot gas and high-pressure air alternately flow through the same flow passages. A well-known example of this latter type of exchanger is the Ljungström air preheater. Selected designs for each type of heat exchanger are presented.

It is stated that regenerative heat exchangers are shown to offer advantages of smaller weight and volume, according to these designs, provided that leakage is not excessive.

Cylindrical Furnaces

Cylindrical Furnaces for the Petroleum Industry, by O. F. Campbell, Mem. ASME, Sinclair Refining Company, East Chicago, Ind. 1949 ASME Semi-Annual Meeting paper No. **49—SA-12** (mimeographed).

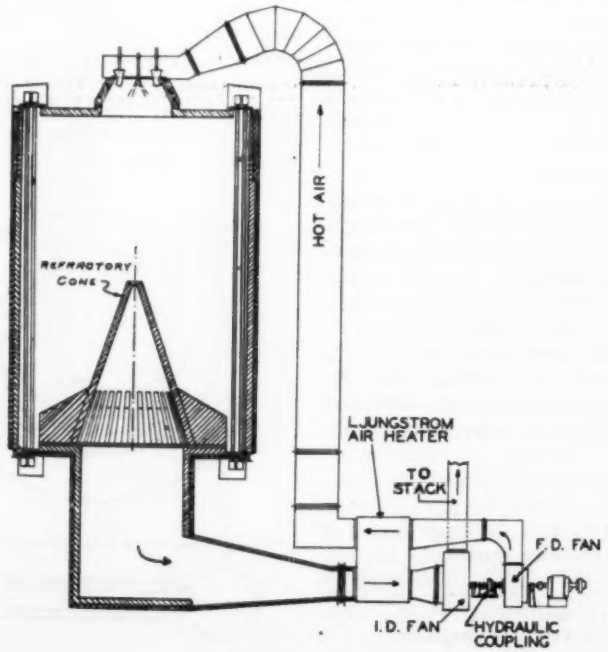
The use of cylindrical furnaces for the petroleum industry has steadily increased since the advent of the original cylindrical furnace invented by Luis de Florez for refinery use some 20 years ago. This type of furnace has not been universally adopted primarily because of a lack of understanding of its capabilities. The purposes of this paper are to describe, discuss, show designs of, provide and comment upon some operating data for

de Florez, Iso-Flow, and other types of cylindrical furnaces.

The cylindrical furnace has been successfully used for many duties such as crude topping, heating reduced crude for vacuum distillation to produce lubricating oils and asphalts, light and heavy gas oil cracking, evaporating and superheating oil vapors for the Houdry and Thermafor catalytic-cracking processes, heating up lube oils and solvents, heating up fat absorption oil for casing-head production, high and low-temperature steam superheating, heating asphalts for loading purposes, domestic heating, and many other uses. Its inherent design is said to provide automatically more uniform heat distribution and absorption, low maintenance, low radiation losses, ease of cleaning, adaptability to heat-recovery equipment, less fire hazard, and low space requirements.

The original design of the de Florez furnace was a down-fired furnace using cold forced air, a bottom convection section, and a natural-draft stack. Subsequent installations had many variations. Some were fired from the bottom with a convection section on top using neither forced nor induced draft. Some were bottom-fired using a convection section and air heater on top and a forced-draft fan. The up-fired units normally do not have induced draft. The air heaters located on top of the furnace were of the tubular or plate type to keep the draft drop to a minimum to avoid the use of a taller stack. The furnace and air heater being vertical, produced a chimney effect and actually served as part of the stack.

The most successful design of the de Florez furnace which has been adopted as a standard by the Sinclair Refining Company, consists of (1) top-supported all-radiant oil-heating tubes, (2) down-firing with a specially designed directional-flame-control oil and gas-fired burner, (3) a vertical refractory cone resting on the bottom of the furnace for better heat distribution, (4) a high-temperature Ljungström air heater, (5) forced- and induced-draft fans motor-driven, and (6) a short self-supporting steel stack.



DOWNDRAFT DE FLOREZ FURNACE EQUIPPED WITH LJUNGSTRÖM AIR HEATER

Metals Engineering

The Forming of a Plastic Sheet Between Fixed Cylindrical Guides With Coulomb Friction, by H. I. Ansoff, Jun. ASME, The Rand Corporation, Santa Monica, Calif. 1949 ASME Semi-Annual Meeting paper No. 49—SA-22 (mimeographed).

The purpose of this investigation was to obtain a rigorous analysis of the drawing of a plastic sheet between two fixed cylindrical surfaces. A number of solutions have recently been given in which the following fundamental assumptions are used: (1) The material between the cylinders is in a state of plane plastic flow, and behaves according to the Saint Venant-Mises theory; (2) the normal stress of the direction of drawing, σ_x, and the normal stress at the boundary, σ_n, are the principal stresses; and (3) the horizontal stress σ_x is constant over each cross section.

In the present treatment only assumption (1) is retained.

This problem has recently been solved by assuming that the shearing stress at the walls is proportional to the relative velocity between the wall and the plastic material.

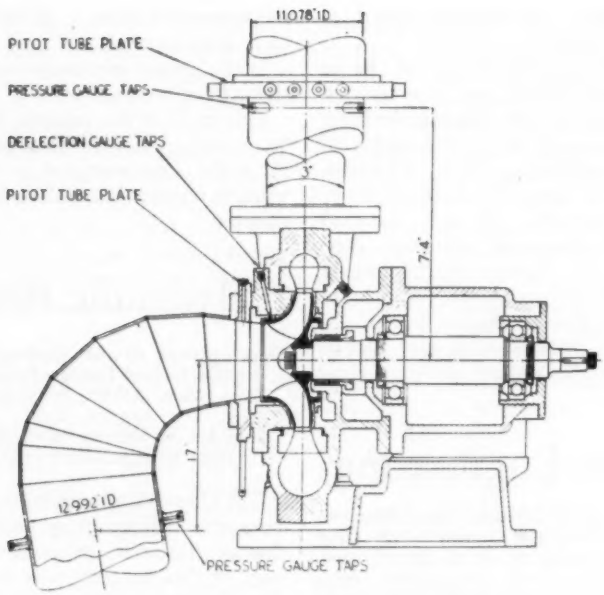
Hydraulic Power

Development of the Hydraulic Design for the Grand Coulee Pumps, by Carl Blom, Mem. ASME, Byron Jackson Company, Los Angeles, Calif. 1949 ASME Semi-Annual Meeting paper No. 49—SA-8 (in type; to be published in Trans. ASME).

The Grand Coulee pumping plant has been the subject of an extensive hydraulic research program. The first part of this program was conducted at The California Institute of Technology for the Bureau of Reclamation from January, 1938, to July, 1940. Some of the results of this program have already been published, and other papers describe the different features of this project. This paper presents some of the results of continued experimental research of the author's company from 1943 to 1946. The investigation covered the effects of various diffuser-type pump cases and impellers on the pump characteristics of the Grand Coulee model. The paper concludes with the description of the final test of the contractor's model completed in July, 1947.

The paper points out that the pump-casing type has a great influence on pump performance, as pumps with single-volute, double-volute, and diffuser casing designed on the same basis will give different performances. Furthermore, the number of diffuser vanes in the diffuser case has a definite influence on the unstable portion of the performance curve. Fewer diffuser vanes reduce the magnitude of the dip in the head-capacity curve. The diffuser-case inlet area affects the shape of the head-capacity curve and also the pump-efficiency curve. Six diffuser vanes seem to be the minimum number for practical design of a welded pump-diffuser-casing structure, which will give the casing sufficient strength and also allow a substantial reduction in weight. A dividing rib in the diffuser case gives better velocity distribution and improves the pump efficiency.

Impellers with the same profile, but with different impeller-outlet vane angles, materially affect the pump size and weight. The steeper vane angle gives a flatter performance curve and



ASSEMBLY, GRAND COULEE MODEL PUMP

produces a more pronounced dip in the unstable head-capacity range.

The impeller-inlet vane design has a great influence on the cavitation characteristics and also affects the unstable portion of the head-capacity and horsepower curves. A flat entrance vane angle reduces the head and horsepower at closed valve and also improves the pump efficiency at lower capacity.

History and Development of the Grand Coulee Pumping Plant, by E. B. Moses, Mem. ASME, Bureau of Reclamation, U. S. Department of the Interior, Denver, Colo. 1949 ASME Semi-Annual Meeting paper No. **49—SA-20** (mimeographed; to be published in condensed form in MECHANICAL ENGINEERING).

A brief history of the Columbia Basin Project in so far as it relates to the Grand Coulee Pumping Plant is given, followed by a general description of the plant, the method of operation, and the mechanical and hydraulic problems involved. This pumping plant is located just upstream from the Grand Coulee Dam and will raise water from Lake Roosevelt a maximum height of 363 ft to the regulating reservoir in the Grand Coulee from which it will be distributed for irrigation purposes over an area of approximately 1,000,000 acres by an extensive system of canals and ditches.

At the present time, 6 pumps are being built, the ultimate installed capacity being 12 pumps of 1445 cfs each under a rated head of 310 ft, and each driven by a 65,000-hp synchronous motor at 200 rpm. The size of these pumps and the ultimate installed capacity far exceed any pump or pumping plant now in operation. To insure a satisfactory hydraulic design for a project of this magnitude, an extensive series of tests were run on models of the intake structure, suction tube, and pump over a period of years from which data the final design was established. The cost of these model tests was paid for many times over by the savings in cost of pumping equipment made possible by reduction in the physical size of units due to an increased speed of rotation.

Six of the existing generating units in the Left Coulee Power Plant are assigned for furnishing power for pumping and will be connected directly through buses without the use of transformers to the pump motors.

The generator and pumping units may be operated at speeds above the normal 60-cycle speed and curves are given showing this relationship as well as the effect of variable reservoir levels and the pressures developed under runaway conditions. The pump operation will be integrated with the general power demand so that there will be a minimum of interference with power demands.

Mechanical Design and Construction of the Grand Coulee Pumps, by Ira Morgan White, Mem. ASME, The Pelton Water Wheel Company, San Francisco, Calif. 1949 ASME Semi-Annual Meeting paper No. **49—SA-21** (mimeographed).

The development of a pump capable of lifting 1350 cu ft of water per sec against a head of 310 ft has required an extensive development program. Close correlation has been required between hydraulic and mechanical designs so that the hydraulic requirement could be met with the least costly type of construction.

Five different types of pump casings have been studied. A careful comparison of the good features of all has led to the ultimate selection of a 6-vane diffuser-type of pump.

With the pump type selected, an extensive development program has been carried out to create the least costly design commensurate with the hydraulic requirements.

The optimum construction from the mechanical standpoint is the 12-vane diffuser pump; however, hydraulic design requirements have necessitated the adoption of the 6-vane pump in order to obtain hydraulic stability through the head range of 270 to 365 ft.

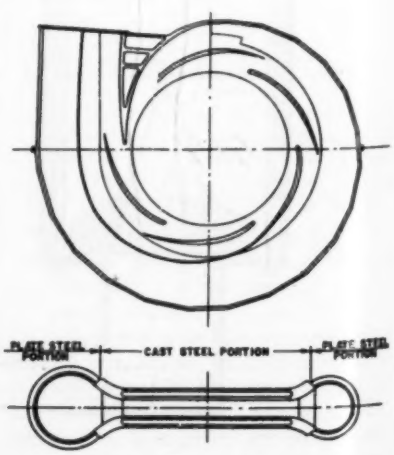
Combination cast-steel diffuser sections with welded plate steel volute are used and provide an economical casing construction.

Flanges which maintain full-face contact are employed and are definitely advantageous from a weight and stress standpoint.

The strain-gage method of analyzing complex structures is utilized and yields valuable information in mechanical design.

The development of the design for the Grand Coulee pumps has shown that the conventional type of pump with its standard volute casing is impractical for large pumps.

The double-volute pump results in considerable weight saving but is not comparable to the multiple-vane diffuser pump which brings about the best mechanical design.



GRAND COULEE PUMP CASING

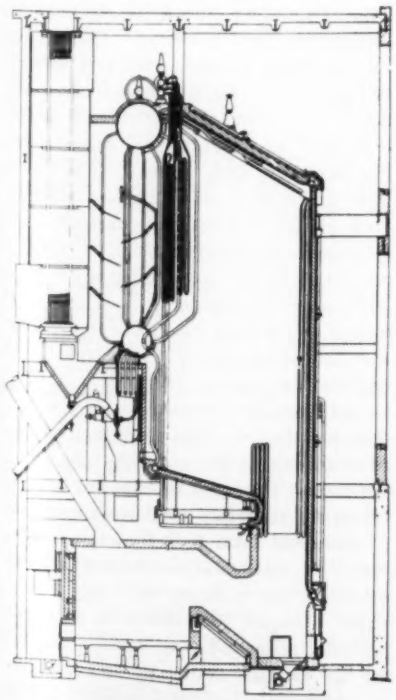
Wet-Wood Burning

Some Recent Developments in Burning Wet Wood, by Otto de Lorenzi, Fellow ASME, Combustion Engineering-Superheater, Inc., New York, N. Y. 1949 ASME Semi-Annual Meeting paper No. **49—SA-31** (mimeographed; to be published in condensed form in MECHANICAL ENGINEERING).

Use of the two-stage furnace, comprising a Dutch oven and a secondary combustion chamber, has been generally accepted as standard for "hog fuel" and other kinds of wet wood refuse.

Recently, however, experimental work has been completed with a design that provides what may seem to be a radical departure from previously accepted standards for wet-wood burning. With this newer approach it is possible to simplify furnace arrangement, reduce width of boiler furnace, and bring many previously noncontrollable factors of older designs to a point where automatic regulation will replace most of the previously required manual adjustments.

The experimental installation consists of a single-stage furnace 20 ft high in the lower part of which is installed a grate 8 ft wide × 8 ft long. Wet wood is supplied by the underfeed method to the grate through a specially designed retort. A reciprocating ram moves the wood from a hopper or bin through the stoker conveyer pipe to the retort.



STEAM-GENERATING UNIT ARRANGED FOR COMBINATION FIRING OF PULVERIZED COAL AND WET REFUSE

The fuel is burned in a pile, but instead of being continually showered downward from above it is gradually forced upward through the pile from the retort. The fuel feed is thus definitely controllable and the external stoker hopper serves as a surge bin to take care of variations in wood supply from the conveyer. Air for combustion is supplied undergrate, as well as overfire by a forced-draft fan. There are no openings through which large noncontrollable quantities of air may flow into the furnace. Thus with this design it is possible to apply automatic regulation, for maintaining desired proportions of fuel and air and thereby maintain more consistently uniform operating conditions.

Other types of wet-wood burning installations discussed are steam-generating units designed to burn both wet wood refuse and pulverized coal, sloping grate furnaces for burning wet bark, and the like.

Plastic Flow

Anisotropic Plastic Flow, by J. C. Fisher, General Electric Research Laboratory, Schenectady, N. Y. 1948 ASME Semi-Annual Meeting paper No. **48—SA-64** (in type; published in Trans. ASME, May, 1949, p. 349).

The mathematical theory of plasticity has been generalized to apply to plastically anisotropic materials. The anisotropic-flow theory has been shown to reduce to the resolved shear stress-shear strain relationship for single crystals, and to the distortion energy theory for isotropic polycrystals. Experimental data concerning the plastic flow of anisotropic polycrystalline aluminum indicate that the predictions of the anistropic flow theory are in good agreement with experiment, and are significantly better than the predictions of the distortion energy theory. As plastic anisotropy is the rule rather than the exception, caution is indicated in interpreting the results of combined stress tests by means of the distortion energy theory.

It is desirable to develop a generalized theory of crystal plasticity which will reduce under the appropriate conditions to the accepted single-crystal and isotropic-polycrystal treatments, and which, in addition, will describe the plastic flow of anisotropic polycrystals. The present paper attempts such a generalization of the theory of plasticity, on the basis of the slip mechanism of plastic deformation common to both single-crystal and polycrystalline materials.

ASME Transactions for July, 1949

THE July, 1949, issue of the Transactions of the ASME contains the following:

Influence of Steel Hardness in Face-Milling, J. B. Armitage and A. O. Schmidt (48—A-30)

Mechanics of Formation of the Discontinuous Chip in Metal Cutting, M. Field and M. E. Merchant (48—A-136)

Constant-Pressure Lathe Test for Measuring the Machinability of Free-Cutting Steels, F. W. Boulger, H. L. Shaw, and H. E. Johnson (48—A-86)

Aerodynamic Heating and Convective Heat Transfer—Summary of Literature Survey, H. A. Johnson and M. W. Rubesin (48—A-39)

Supersonic Convective Heat-Transfer Correlation From Skin-Temperature Measurements on a V-2 Rocket in Flight, W. W. Fischer and R. H. Norris (48—A-54)

Correlation of Performance Characteristics of Domestic-Stoker Coals With Their Chemical and Petrographic Composition, R. J. Helfinstine and G. H. Cady (48—FU-1)

An Evaluation of the Performance of Thirty-Three Residential-Stoker Coals, J. B. Purdy and H. W. Nelson (48—FU-3)

Marine Propulsion-Gear Testing at the Naval Boiler and Turbine Laboratory, I. Monk (48—A-50)

The Parallel Development of Heavy Self-Contained Hydraulic Presses in the United States and Great Britain, F. H. Towler (48—A-33)

Elements of Graphical Solution of Water-Hammer Problems in Centrifugal-Pump Systems, A. J. Stepanoff (48—A-89)

Involute-Gear Geometry, C. E. Grosser (48—A-73)

Film-Pressure Distribution in Grease-Lubricated Journal Bearings, G. Cohn and J. W. Oren (48—A-31)

Viscosities and Densities of Lubricating Fluids From —40 to 700 F, C. M. Murphy, J. B. Romans, and W. A. Zisman (48—A-147)

Strength and Failure Characteristics of Metal Membranes in Circular Bulging, W. F. Brown, Jr., and F. C. Thompson (48—A-11)

A Reconsideration of Deformation Theories of Plasticity, D. C. Drucker (48—A-81)

Power-Plant Cycle Evaluation, J. K. Salisbury (48—A-57)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Successful Engineers

COMMENT BY JAMES KIP FINCH[1]

While the writer does not question the data given in Dr. Prentice's recent paper,[2] they involve some serious omissions which cannot fail to give the general reader a false impression. Although engineering schools or colleges, which form part of a university group, are included in Table 1, these "university engineering schools" are omitted in the tabulation and ratings given in Table 2. The author uses the term "similar colleges" in this latter comparison, thereby limiting the study to independent isolated engineering colleges—those which have no university affiliations. He certainly would not hold that only these isolated schools turn out "successful engineers," yet he ignores the performance of "university engineering colleges" in his final ratings.

It seems quite clear that this latter "university" group of schools not only has exercised an important influence in advancing the standards of American engineering education but that such schools, through their university relationships, possess some major advantages as engineering educational institutions. This has been especially true during the present century when the character of engineering courses has been evolving from the level of rather narrow technical instruction to the higher standards of real professional education. This evolution naturally has made it necessary for all schools with professional ambitions to strengthen their offerings in mathematics and natural science and to add suitable general educational subjects especially English, as well as the study of modern economic, social, and political institutions. University schools have led in this movement and are especially favorably placed to support it, for they have strong departments of mathematics, natural science, economics, history, and kindred subjects on which to draw for these essential elements in professional education.

Therefore, it might be interesting to make a comparison between the "similar colleges" of the author's Table 2 and "university colleges." Yet each institution not only has its own peculiar traditions and interests but its own opportunities and responsibilities. Such "Who's Who" comparisons offer little evidence of how successful a particular institution has been in achieving its special possibilities. Furthermore, we do not have at hand the essential data on the number of graduates needed to complete Table 2. We have no doubt, however, that, if such data were available, the university schools would show up among the top ratings on the author's list.

Columbia's School of Engineering, for example, has 5672 living engineering alumni of whom 281 are noted in Table 1, as listed in "Who's Who in Engineering." This is a percentage rating of 4.88 which would put this school at the top of the list. But this method of measuring success is clearly not satisfactory. A large percentage of our "successful" graduates—and the same is undoubtedly true of other schools—are in managerial, executive, and other positions which, while they may be related to engineering, would not lead such alumni to desire inclusion in a professional engineering "Who's Who" listing.

TO THE EDITOR:

Dr. Prentice's analysis in the May issue of MECHANICAL ENGINEERING showing results of technical graduates based upon their appearance in "Who's Who in Engineering" is both interesting and valuable. As pointed out, this yardstick is only one among many for measuring the success of any individual technical school. Of course, too, there is variation in the objectives of such institutions.

Only in recent years are we coming to realize that many of the greatest problems encountered by engineering graduates are not of a technical nature. Industry is differentiating to a greater degree between technicians on the one hand, and, on the other, technically trained men who have broad vision and understanding—qualities which give meaning and guidance to technical accomplishment in a gadgetized world.

Various demands are being made to prepare our technical graduates for these changing conditions, i.e., crowd into a four-year course subjects labeled as "Humanities"; extend the four-year period to five; relegate more technical work to a period of graduate training; or depend to a greater extent upon industry for specialized technical training.

One of the greatest values, to my mind, in Dr. Prentice's analysis, comes from what we may learn as to the type of training which leads to the highest success.

Strangely enough the graduates of some institutions not giving a variety of highly technical courses, stand high on the list based on their size. This points to the importance of man development rather than channeling all his particular skill.

Each reader of Dr. Prentice's article will seek the name of his own institution, note its standing, and try to evaluate the reasons for its position. The writer springs from a small arts and science college of early origin—Haverford. Long before the turn of the century it established an engineering department, but purposely only about half the subjects given deal with applied science. Such subjects are basic in character. As a result its engineering course is not approved by ECPD and industrialists generally do not recognize it as a technical school. Yet with its 2900 living graduates, of which only 275 have taken the engineering course, it holds a rating, according to Dr. Prentice's table, of approximately 4.4. The point is, that its chief attempt is not to develop engineers, but men. The emphasis has not been on filling the student's mind with a variety of technical facts and formulas. It is rather to create an atmosphere for growth wherein the students will be led to think straight and deep, discriminate between false and true, and be inspired by an earnest desire to investigate—to serve—in a technical world with all its crosscurrents of fact and emotion.

This institution is by no means the

[1] Dean, School of Engineering, Columbia University, New York, N. Y.

[2] "College Antecedents of Successful Engineers," by D. B. Prentice, MECHANICAL ENGINEERING, vol. 71, May, 1949, pp. 397–398, and 402.

sole example of where emphasis in training centers upon the individual rather than the mass. But it does serve to furnish the straw to add weight to the argument that what may be most important in engineering education is not measured by the quantity or variety of technical subjects composing the curriculum.

Dr. Edward R. Eastman, member of the State Board of Regents of New York, this month told the graduating class of Ithaca College:

"Unless we can find a way—and soon—to balance material progress, we may commit world suicide by means of our own marvelous gadgets."

BERNARD LESTER.[3]

AUTHOR'S REPLY

The author agrees wholeheartedly with nearly everything Dean Finch writes. He regrets very much that there is, apparently, no fair way by which the engineering schools which are parts of universities, and these include some of the leading institutions in the country, can be compared with the separate engineering schools. Certainly the omission of these schools from Table 2 of the paper implied nothing in regard to their quality. It was hoped and believed that the explanation of the basis upon which individuals were assigned to colleges covered the situation.

The paper is entitled, "College Antecedents of Successful Engineers," and in the first paragraphs the measure of success is stated as inclusion in "Who's Who in Engineering." The author would be the last to argue that all successful engineers are listed in this volume or even that every engineer listed would satisfy all definitions of success. However, it is believed that omissions and inclusions are entirely unrelated to college antecedents and that the distribution among institutions, Table 1, gives a reasonable picture of the institutions' contributions to leadership in the engineering profession.

The only statement in Dean Finch's letter with which the author cannot agree is that relating to the reason why engineering schools of universities cannot be included in Table 2. Dean Finch assumes that the 281 individuals assigned to Columbia are graduates of the School of Engineering. He says, "Columbia's School of Engineering, for example, has 5672 living engineering alumni of whom 281 are noted in Table 1 as listed in Who's Who in Engineering." Nowhere in the paper is it stated that graduates assigned to universities are in every case graduates of the engineering schools. In fact the reference to the University of Chicago makes it clear that graduates of the arts colleges in chemistry, physics, geology, and the like, are sometimes employed in engineering work of sufficient importance to entitle them to listing in "Who's Who in Engineering." This is undoubtedly true of Columbia.

If biographies were complete and degrees were reported by colleges within universities, a breakdown of the Columbia group might be possible. In that case the author is positive both that the percentage of engineering alumni would be relatively high, and that it would be lower than Dean Finch's figure.

Finally, it may be pointed out that the paper does not deal with "successful" graduates, only with those presumably successful "as engineers."

DONALD B. PRENTICE.[4]

Horsepower

TO THE EDITOR:

The recent article on horsepower[5] proved most interesting and brought to mind some statements on the subject which the writer came across in the "Mechanic's Calculator," by William Grier, civil engineer, Glasgow, Scotland, and dated 1855. In the current article there appears the statement: "Although it is known that a horse cannot work continuously at the standards so set, Watt's figure has never been modified." This statement gives the general impression that immediately after Watt's value for the horsepower equivalent was published in January, 1809, it was accepted generally and used without modification from that time on. Apparently this was not the exact case, and I presume that there was general difference of opinion as to the horsepower equivalent for a number of years, based upon a statement which appears in the "Mechanic's Calculator."[6] A general example is given to show that the power of a steam engine is equivalent to raising a weight of 5000 lb through 200 ft in a minute. The following statements are then made:

"This is the most certain measure of the power of a steam engine. It is usual, however, to estimate the effect as equivalent to the power of so many horses. This method, however simple and natural it may appear, is yet, from differences of opinion as to the power of a horse, not very accurate; and its employment in calculation can only be accounted for on the ground that, when steam engines were first employed to drive machinery, they were substituted instead of horses; and it became thus necessary to estimate what size of a steam engine would give a power equal to so many horses.

"There are various opinions as to the power of a horse. According to Smeaton, a horse will raise 22,916 lbs—one foot high in a minute. Desaguliers makes the number 27,500; and Watt makes it larger still, that is 33,000. There is reason to believe that even this number is too small, and that we may add at least 11,000 to it, which gives 44,000 lb raised one foot high per minute."

Following this quotation, this old handbook points out that the 1,000,000 ft-lb of work accomplished in 1 min by the sample steam engine are equivalent to a different number of horses' power according to each of the different physicists, depending upon which horsepower-equivalent value is used.

The first time the writer saw the foregoing statement in the old handbook, he was forcibly struck by the fact that what he had been taking for granted as an established value, apparently had been in some dispute, and probably for many years, at the time the handbook was written. Upon reading the recent article this reaction was recalled. It may serve as a constructive addition to this interesting subject. C. R. PLUM.[7]

[3] Management Engineer, New York, N. Y. Mem. ASME.

[4] Formerly President, Rose Polytechnic Institute, Terre Haute, Ind. Fellow ASME.

[5] "Horsepower," MECHANICAL ENGINEERING, vol. 71, May, 1949, p. 413.

[6] Page 283.

[7] Aviation Division, General Electric Company, Schenectady, N. Y. Jun. ASME.

Digests of ASME Meetings Papers

DIGESTS of available preprints of papers presented at the ASME Semi-Annual Meeting, held in San Francisco, Calif., June 27–30, 1949, and the ASME Applied Mechanics Division Conference, held in Ann Arbor, Mich., June 13–15, 1949, appear in this month's ASME TECHNICAL DIGEST, pages 681–687.

Pamphlet copies of the complete papers are available at 25 cents each to members and 50 cents each to non-members from ASME Order Department, 29 West 39th St., New York 18, N. Y.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

George Stephenson

GEORGE STEPHENSON: Father of Railways. By Ada Louise Barrett. The Paebar Co., New York, N. Y., 1948. Cloth, $5^1/_4 \times 8^1/_2$ in., illus., bibliography v–vii, vii and 287 pp., $3.75.

REVIEWED BY SIDNEY WITHINGTON[1]

THIS is a readable little biography addressed, according to the author "primarily to the average reader, not to the engineering world," so perhaps she may be excused for some vagueness in technical details.

The early chapters treating of Stephenson's family and childhood are pleasant and are presumably accurate, although there are numerous anecdotes—not only indeed in the early chapters, but throughout the book—which are so gossipy that one cannot help wondering whether the author (or some source from which she took her data) has not indulged in a certain amount of imaginative fiction in the interest of atmosphere.

Since, as has been indicated, the book is not intended for engineers, this lack of technical accuracy is perhaps not of great importance. It would have done no harm however if the author had paid more attention to technical details, and also had she given the authority for some of her statements.

As instances, there are among other episodes included, the story of young Stephenson's kite which he employed to shock electrically his father's horse and his neighbors' cows, and also the reference to young George's setting up in less than a week a "little engine no bigger than a kail-pot" (whatever that is) to pump out a quarry where other means had failed. It is difficult to be'ieve either of these tales and one cannot escape the suspicion they are apocryphal.

An interesting chapter is devoted to Stephenson's "Geordy Safety Lamp" and the author presents a vigorous *ex parte* claim for credit for Stephenson's priority in that very important invention over Sir Humphrey Davy's. It would have added to the interest and value of the book if she had included the other side of the picture (that is, the data presented by Sir Humphrey's supporters), even if only to refute it.

One small point should be corrected in the author's description of a seventeenth-century tram road where she says "sleepers were laid the width of the road which was four feet eight and one-half inches and the rails placed on top of them." Since, at that time, the tram rails and not the wheels were flanged, the width of that early road was more than the finally adopted standard gage.

It has been generally accepted as a historical conclusion that the term "tramway" did not originate with Benjamin Outram, as the author says, in spite of his early activities in tramway operation, but came from the Norse "trams" or waggons, which were used long before Outram appeared on the scene.

The author indicates that Stephenson's little locomotive the Blucher of 1814 "did the work of 50 horses." This is somewhat misleading and one tenth of that figure would be a more appropriate guess. A reference to the source of that figure would have been of interest.

A picturesque bit of history which is referred to is in connection with the opening of the Stockton and Darlington Railway in 1825. The fire in the pioneer locomotive on that occasion was started prior to its first run by a burning-glass using the rays of the sun. It is very doubtful, however, that Stephenson "asked casually for a match" or that the men and boys "ransacked every pocket . . . . ." as a story is told here. Matches were not commercially available for a good many years after that memorable day.

The author's enthusiasm again runs away with her when she says that Stephenson was the "best railroad engineer in the country, in fact the only one" and that he was the "greatest mechanical genius the world has ever known." Many students of history are likely to take exception to these enthusiastic comments which would have been more convincing if they had been a little more moderate.

The contemporary descriptions of railway travel in those early days are among the most interesting and valuable passages in the book. It is hard for us who ride in modern high-speed trains, over modern railroad tracks (rough as we think sometimes some of them are even today!) to visualize the early railroad travel picture which, of course, was a great improvement over the highway travel of the period. It would have added to the interest and value of those contemporary quotations if the author had given the sources. She is also a little sketchy sometimes in explaining some of the causes of the discomforts of that early travel, as for instance when she says that one of the reasons was that "the locomotive wheels were firmly fastened to the axles" which of course has not only always been the case but is so today.

It is unfortunate that, as has been indicated, the sources of statements, quotations, and illustrations are not given. Another serious omission is an index which should always be included in a book of this nature. A glossary of some of the terms used would also have added to the value, especially for those not familiar with North of England terms and who do not have access to an unabridged dictionary. A few of such terms, among a number of others which troubled the present reviewer, are *staith*, *crowdie*, *kail*, *rolly*, etc.

The bibliography is quite intriguing for those who are interested in further study of early-nineteenth-century railroad transportation, but is sadly incomplete in proper identification of some of the references, including the dates of publication, authors' full names, publishers of the works referred to and, especially in the case of manuscripts, where they may be found.

These comments are perhaps unduly captious because the biography is very readable and is a pleasant addition to railroad literature.

[1] Engineering Assistant to the vice-president, New York, New Haven and Hartford Railroad Co., New Haven, Conn. Mem. ASME.

Books Received in Library

CONCISE ENCYCLOPEDIA OF WORLD TIMBERS. By F. H. Titmuss. Philosophical Library, New York, N. Y., 1949. Fabrikoid, $5^3/_4 \times 8^3/_4$ in., 156 pp., $4.75. This book is designed

to serve as a connecting link between the laboratory worker and the man in the workshop and to be a handy reference book for all whose work necessitates an understanding of timber. It includes detailed descriptions of nearly 200 different timbers, with macroscopic identifications of the woods in more common use. One section describes in brief detail the growth of the tree, the anatomical structure of wood, and the features which lead to its correct identification.

DIESEL ENGINES. By J. W. Anderson. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 556 pp., illus., diagrams, charts, tables, $7. This practical book on Diesel engines shows what they are, what they do, how to select them for specific purposes, and how to operate them. It gives a comprehensive picture of American engines, and some European, classifying them according to general service applications. This new edition includes important developments in the field. It discusses engine design and principles, feed-oil injection, fuel oils, and engine applications in the light of current practices and trends.

ELEMENTS OF AERODYNAMICS OF SUPERSONIC FLOWS. By A. Ferri. The Macmillan Company, New York, N. Y., 1949. Cloth, 6¼ × 9½ in., 434 pp., illus., diagrams, charts, tables, $10. Presented from a practical engineering point of view, this book explains the theoretical fundamentals of both two- and three-dimensional flow. It shows in detail the application of theory to such aeronautical-engineering problems as instruments, diffusers, and wing design. Theory is explained as clearly and simply as possible, and many examples of analysis for particular problems are included. There is also new material on various topics that will be of value to both design engineers and those working on the theoretical aspects of high-speed flow.

ENGINEERING TOLERANCES. By H. G. Conway, Sir Isaac Pitman & Sons, Ltd., London, England, 1948. Cloth, 6 × 9 in., 286 pp., illus., diagrams, charts, tables, 30s. A practical guide for mechanical engineers, designers, and draftsmen, this book is a comprehensive study of tolerances, limits, and fits for engineering processes, designed to insure manufacturing accuracy. It explains the scope of the various published limit systems, and instructs the designer in the proper use of such systems. A useful feature is the inclusion of tolerance tables.

FINE SURFACE FINISH. By S. F. Page. Chapman & Hall, Ltd., London, England, 1948. Cloth, 5½ × 8¾ in., 185 pp., illus., diagrams, charts, tables, 16s. Of interest to designers, draftsmen, engineers, and engineering students, this book deals in an authoritative manner with metalworking surface finishing. It describes the various aspects of surfaces and also their production, use, metallurgy, measurement, and inspection. Many illustrations and diagrams are included.

FOUNDATIONS OF NUCLEAR PHYSICS, with Bibliography compiled by R. T. Beyer. Dover Publications, New York, N. Y., 1949. Cloth, 6¼ × 9½ in., 272 pp., illus., diagrams, charts, tables, $2.95. This book contains facsimiles of thirteen previously published fundamental studies as originally reported by the investigators. It also provides a comprehensive but unannotated bibliography of over 5000 references to articles, classified under broad subject headings. Only last names of authors are given and only the first page of each article.

FUELS AND LUBRICATING OILS for Internal-Combustion Engines. By B. Pugh and J. M. A. Court. Sir Isaac Pitman & Sons, Ltd., London, England, Pitman Publishing Corporation, New York, N. Y., 1949. Cloth, 5 × 7½ in., 169 pp., diagrams, charts, tables, 15s; $3.50. This book deals in an elementary manner with the major topics of hydrocarbon chemistry, the manufacture of fuels and lubricants from petroleum, and combustion. Also discussed are antiknock ratings, significance of the chemical and physical properties of fuels, elementary principles of lubrication, and the meaning and significance of lubricating-oil tests.

HEATING VENTILATING AIR CONDITIONING GUIDE, Volume 27, 1949. American Society of Heating and Ventilating Engineers, New York, N. Y., Cloth 6¼ × 9¼ in., 1384 pp., illus., diagrams, charts, tables, $7.50. This standard manual constitutes both a textbook and handbook on the design and specification of heating, ventilating, and air-conditioning systems. The technical-data section is enlarged by some eighty pages owing to revisions and additions in accordance with current practice. The catalogue-data section has been increased by the addition of up-to-date products of many additional manufacturers.

INDENTATION HARDNESS TESTING. By V. E. Lysaght. Reinhold Publishing Corporation, New York, N. Y., 1949. Cloth, 6 × 9¼ in., 288 pp., illus., diagrams, charts, tables, $5.50. Of value to metallurgists, testing engineers, machine operators, and students, this book covers the many problems involved in the hardness testing of metals and other materials. It describes the instruments in most common use, as well as those used for specialized types of hardness tests. The advantages and disadvantages of each instrument are evaluated. Recent advances in the field are dealt with in detail and the work of present hardness committees of the leading technical societies is considered.

INFLUENCE OF CERTAIN FACTORS ON THE PERFORMANCE OF SHELL-TYPE BOILERS, compiled by E. G. Ritchie. British Coal Utilisation Research Association, London, S.W. 1, and Randall Road, Leatherhead, Surrey, England, 1948. Paper, 7¼ × 9¾ in., 152 pp., illus., diagrams, charts, tables, 12s, 6d. This report is mainly concerned with shell-type boilers for industrial purposes, i.e., Lancashire and Economic boilers and their firing equipment. It is divided into five parts: the influence of excess air; the influence of rating; the influence of fuel characteristics; the measurement of flue-gas temperature; and surface heat loss in shell boilers.

JET PROPULSION, TURBOJETS. By V. C. Finch. National Press, Millbrae, California, 1948. Cloth, 5½ × 8¾ in., 328 pp., illus., diagrams, charts, tables, $5.50. Based on recently released technical information on the world's aircraft gas-turbine power plants, this book presents a picture of jet propulsion for any one interested in aviation. It offers a technical treatment of the history of the gas turbine and the practical application of aerothermodynamics to analysis, design, and operation of turbojets. References are given at the end of each chapter and many illustrations are included.

MATHEMATICS FOR INDUSTRY. By S. E. Rusinoff. American Technical Society, Chicago, Ill., 1949. Cloth, 5½ × 8½ in., 519 pp., diagrams, tables, $5.50. This text presents in simplified form the mathematics most often needed in the field of practical engineering and machine-shop practice. It concentrates on actual problems of engineering, shop, and drafting room, and applies basic mathematics to jobs encountered in everyday industry. Simple terms and expressions are used to described methods and procedures and numerous illustrations are included.

METALLURGICAL STUDY OF GERMAN AIRCRAFT ENGINE AND AIRFRAME PARTS, Part 2. By the Aero Component Subcommittee of the Technical Advisory Committee to the Special and Alloy Steel Committee, arranged by C. A. Otto. Kennedy Press Ltd., 31 King Street West, Manchester 3, and Bedford Street, London, W.C.2, England, 1948. Cloth, 5¾ × 9¼ in., 110 pp., illus., diagrams, charts, tables, 10s, 6d. This report constitutes a summary of data resulting from metallurgical examination of German aircraft engine and airframe parts. It contains information on the types and qualities of the materials used, methods of manufacture, efficiency of the heat-treatment to which the parts have been submitted, and other pertinent subjects. Special features concerning design are noted in certain instances. No comparisons are made with corresponding parts in British and American aircraft.

NUMERICAL METHODS OF ANALYSIS IN ENGINEERING (Successive Corrections). By H. Cross and others, a Symposium at Illinois Institute of Technology, Chicago, Ill., arranged and edited by L. E. Grinter. The Macmillan Company, New York, N. Y.; 1949. Cloth, 6¼ × 9½ in., 207 pp., illus., diagrams, charts, tables, $5.80. This volume contains papers on methods and techniques of numerical analysis which are applicable in many fields of engineering and science. Divided into four sections, the first three discuss numerical methods based upon physical concepts, numerical solutions of equations for state of stress, and applications of numerical methods to heat transfer. Surveys and bibliographies of numerical methods make up the final section.

OXYACETYLENE WELDING AND CUTTING, a Course of Instruction. By S. Plumley, revised and rewritten by T. B. Jefferson. Fourth edition. McGraw-Hill Book Company, Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, 8¼ × 11½ in., 356 pp., illus., diagrams, charts, tables, $6.50. This book fills the need for a concise, easy-to-understand course of instruction in oxyacetylene welding and cutting techniques. It begins with basic principles and proceeds, step by step, to show how to develop skill in handling both repair and production work. Particular stress is placed on pipe welding and the newer techniques in the welding of alloy steels, aluminum and magnesium, silver brazing, and hard facing. Most chapters close with exercises and questions.

PLANNING THE UNIVERSITY LIBRARY BUILDING. Edited by J. E. Burchard, C. W. David, and J. P. Boyd. Princeton University Press, Princeton, N. J., 1949. Cloth, 5½ × 8¾ in., 145 pp., diagrams, $2.50. A summary of discussions by librarians, architects, and engineers, this book provides information on all aspects of the subject. It is the result of the co-operative work of several institutions of higher learning. Some of the problems discussed are the latest and most ingenious methods of illumination and air conditioning, planning for flexibility and growth, and the merits of functional versus traditional architecture.

PLANT PRODUCTION CONTROL. By C. A. Koepke. Second edition. John Wiley & Sons,

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1949. Cloth, 6 × 9¼ in., 568 pp., illus., diagrams, charts, tables, $5.50. A broad background is presented of the problems of production planning and control as they apply to a variety of industrial situations. In this second edition there is a greatly expanded coverage of the position of the planning and control function and the mechanism of operational detail. New practical examples, forms, and problems along with theoretical discussions are included, and there is a fresh approach to the problem of economic purchase and manufacturing quantities.

DER PRAKTISCHE WÄRME- UND SCHALLSCHUTZ IM HOCHBAU. By F. Bruckmayer. Franz Deuticke, Vienna, Austria, 1949. Paper, half linen, linen, 6½ × 9½ in., 126 pp., illus., diagrams, charts, tables, paper, 14 Swiss fr.; bound half linen, 16.50 Swiss fr; all linen, 18 Swiss fr. This book presents the basic principles of both thermal insulation and soundproofing in buildings. Thermal insulation during heat transmission in a constant state, thermal storage devices, and thermal requirements are discussed. Soundproofing for internal and external noises is considered and brief mention is made of vibration insulation.

PROCESS AND PHYSICAL METALLURGY. By J. E. Garside. Charles Griffin & Company, Ltd., London, England, 1949. Cloth, 6 × 9 in., 499 pp., illus., diagrams, charts, tables, 40s. Written from the viewpoint of the user of the metals and alloys, this book gives an account of some of the chief aspects of process and physical metallurgy. Methods of fabrication, fuels, refractories, furnaces, molding materials, and the various processes of mechanical deformation of metals and alloys are dealt with fully. Iron, copper, light metals, nickel, lead, and zinc are considered, as well as their alloys. Numerous illustrations and tables are included.

PROPERTIES OF METALS IN MATERIALS ENGINEERING. By R. L. Templin and others. American Society for Metals, Cleveland, Ohio. 1949. Cloth, 6 × 9¼ in., 177 pp., illus., diagrams, charts, tables, $5. This series of eight lectures was presented during the Thirtieth National Metal Congress. Following an introduction, the fundamental concepts as related to the properties of materials for engineering design are considered. Other lectures discuss direct loading of metals, fatigue strength, stress determination, stresses in aircraft engines, engineering design testing, and design for energy absorption.

REFRIGERATING PRINCIPLES AND PRACTICES. By N. Sharpe. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 398 pp., diagrams, charts, tables, $4. This book is intended to assist students in integrating the principles and practices of the refrigerating industry. These principles and their application to the selection or design of equipment are presented in parallel arrangement. Material is presented in the order in which the engineer would make calculations for a typical installation. The American Standard Safety Code for Mechanical Refrigeration is included, as well as numerous tables.

TABLES OF GENERALIZED SINE AND COSINE-INTEGRAL FUNCTIONS: Parts 1 and 2 (Annals of the Computation Laboratory of Harvard University, Volumes 18 and 19). By the Staff of the Computation Laboratory. Harvard University Press, Cambridge, Mass., 1949. Cloth, 8 × 10¾ in.; part 1, 462 pp.; part 2, 560 pp.; charts, tables, $10. each volume. The introduction to this two-volume set describes the characteristics, computation, and interpolation of the functions considered. The six-place tables, expanded from short tabulations prepared for war work, are useful mathematical tools for the investigation of such questions as self and mutual impedances, radiation resistance, and distribution of current in antennas and antenna arrays of various types.

THEORY OF OSCILLATIONS. By A. A. Andronow and C. E. Chaikin. English edition edited under the direction of S. Lefschetz. Princeton University Press, Princeton, N. J., 1949. Cloth, 6 × 9¼ in., 358 pp., diagrams, charts, tables, $6. This book is a condensed version of one published in 1937 in Russian and containing the first extensive treatment of nonlinear oscillations. It begins with a treatment of linear systems, but progresses to various types of nonlinear systems using both mechanical and electrical examples. Special attention is given to self-excited oscillations. There is a bibliography of the most accessible books and papers.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is submitted to the Board on Codes and Standards, as authorized by the Council of The American Society of Mechanical Engineers, for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of May 17, 1949, and approved by the Board on Codes and Standards under the date of July 8, 1949.

CASE No. 879

(Reopened, Special Ruling)

Inquiry: Is it permissible, under the Code for Unfired Pressure Vessels, to single fusion butt-weld circumferential joints in seamless nickel-copper tubing complying with Specifications SB-163 and SB-165, or copper-nickel tubing complying with Specification SB-111, 80-20 type A or 70-30, having a maximum outside diameter of 1¼ in., and a maximum wall thickness of 0.18 in., when the joints are to be oxyacetylene welded with complete fusion to a depth not less than the metal thickness?

The process and welding operators would be qualified under Par. P-112, with the following exceptions:

(1) The qualification tests will be made in accordance with the provisions in Case No. 1022 for pipe or tubing welds;

(2) The tubes will be welded only in the horizontal position and revolved during the welding process so that the weld metal will be deposited vertically downward;

(3) All such welded joints are hydrostatically tested to 1½ times the working pressure or a minimum test of 1000 psi.

(4) Stress-relieving is not required and the excess weld metal or reinforcement shall not be removed.

Reply: It is the opinion of the Committee that the fusion welding of tubing in accordance with the limitations stated in the inquiry will meet the requirements of the Code for Unfired Pressure Vessels.

CASE No. 935

(Annulled)

CASE No. 1022

(Reopened)

Inquiry: Par. Q-205 of the Code requires welding-operator tests for groove welds to be made in materials ⅜ in. thick and that when using pipe or tubing, the nominal diameter shall be not less than 6 in. Is it mandatory that these values be adhered to in all Cases?

Reply: The tests described in Par. Il

of the Welding Qualification Section of the Code are intended for universal qualification of a welding operator and the diameter and the thicknesses designated were chosen for that purpose.

In arc welding, material having a thickness less than 3/8 in. may be used, but in that case the operator shall not be considered qualified for a thickness greater than twice that used in the tests.

In gas welding, material having a thickness less than 3/8 in. may be used but in that case the operator shall not be considered qualified for any greater thickness than that used in the tests.

In both arc welding and in gas welding, pipe, or tubing having a nominal diameter of less than 6 in. may be used.

The curvature of a specimen made with pipe or tubing, which is to be tested in the guided-bend test jig may be decreased by finishing off the outer weld reinforcement and by machining the underside of the specimen flat without decreasing the thickness of the specimen at its longitudinal center line.

If the thickness of the test specimen is other than 3/8 in., the testing shall be done in a guided-bend test jig with the plunger and the die member proportioned as follows:

Thickness of plunger member = 4 × thickness of test specimen
Radius of plunger member = 2 × thickness of test specimen
Width of opening, die member = 6 × thickness of test specimen plus 1/8 in.
Radius of die member = 3 × thickness of test specimen plus 1/16 in.

In the case of pipe or tubing having dimensions such that testing in a guided-bend test jig can not be done satisfactorily, the specimen shall be prepared by simulating the full procedure proposed for the actual work to be done. The specimen shall be of the dimensions and shall be tested as shown in Fig. 43. (Fig. 43 as previously published.) When so tested the specimen shall develop the full specified minimum tensile strength of the annealed base material (minimum of the range) when tensile strength is covered in the material specification involved.

CASE No. 1091

(Special Ruling)

Inquiry: May aluminum-alloy die forgings be used in the construction of unfired pressure vessels if no welding of the forging is involved and if the design is made in accordance with the general rules of the ASME Code, Section VIII? (Case 994 now allows the use of sheet and plate of alloy M1 of SB-178 for vessels made in accordance with Pars. U-69 and U-70).

Reply: Aluminum-alloy die forgings may be used in the construction of unfired pressure vessels provided the design is in accord with the general rules of the Code and the following:

(1) The chemical composition and mechanical properties shall conform to those of alloy CS41 of ASTM Specification SB211-48T, except that the yield strength requirement for the T4 temper shall be 30,000 psi.

(2) The maximum allowable design stresses in tension and compression shall be:

	—Design Stress, psi—	
	T4	T6
Temperature, deg F	temper	temper
up to 100 (incl. subzero)	11 000	13 000
150	10 300	12 700
200	9 600	12 300
250	8 700	11 800
300	8 100	8 700
350	4 700	4 700
400	3 250	3 250

(3) Gas or arc cutting shall not be used.

(4) Edges of sheared parts beveled for caulking shall have at least 1/8 in. of material removed by a machining process.

(5) Rivets shall be of a suitable aluminum alloy.

(6) Bolts shall be of a suitable aluminum alloy or ferrous material.

(7) Backing rings and cover plates for manholes, handholes, inspection openings, etc. shall be of the composition of the forging or alloy M1 of SB-178 or of a suitable ferrous material.

(8) Under some conditions metals used in combination with aluminum alloys may cause electrolytic action; under such conditions suitable precautions shall be taken to avoid this kind of attack.

CASE No. 1093

(Canceled)

CASE No. 1098

(Special Ruling)

Inquiry: The use of chromium-nickel-alloy steels is authorized by Case No. 897 but the specifications authorized for use do not include ASTM Specification A-270-47 Seamless and Welded Austenitic Stainless Steel Sanitary Tubing intended for use in the dairy and food industries. For these uses, a superior type of finish is required as provided by that specification. May tubing made to ASTM Specification A-270-47 be used in the construction of Code vessels?

Reply: It is the opinion of the Committee that tubing made to ASTM Specification A-270-47 may be used in the construction of Code vessels intended for use in industries requiring the superior surface finish in this specification provided the following restrictions are met: The tubes shall not be rolled into tube holes or welded. The working pressure shall not exceed 250 psi internal pressure or 100 psi external. The service temperature shall not exceed 700 F.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph numbers to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. U-37(b). Revise to read as follows:

If a dished head is formed with a flattened spot or surface, the diameter of the flat spot shall not exceed that allowable for flat heads as given by the formula in Par. U-39 using $C = [0.40]\ 0.25$.

PAR. P-196(b) revise to read as follows:

If a dished head is formed with a flattened spot or surface, the diameter of the flat spot shall not exceed that allowable for flat heads as given by the formula in Par. P-198, using $C = [0.40]\ 0.25$.

Add as a part of U-142.

WHEN THERE ARE SEVERAL PRESSURE PARTS BEING WELDED IN SUCCESSION ON ANY ONE ORDER, THE PLATE THICKNESSES OF WHICH FALL WITHIN A RANGE OF 1/4 INCH, WITH DIAMETERS DIFFERING NOT MORE THAN 6 INCHES AND OF THE SAME GRADE OF MATERIAL, A TEST PLATE SUBJECT TO THE REQUIREMENTS IN (1) SHALL BE FURNISHED FOR EACH 200 FT, OR FRACTION THEREOF, OF THE MAIN WELDED JOINTS.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

EJC Takes Up Broad Professional Matters at June Meeting

How to encourage more effective utilization of engineers by the National Military Establishment, a job classification for military engineering personnel, an international federation of professional-engineering societies to affiliate with the United Nations as world-wide representative of the engineering profession, were some of the matters of far-reaching import to American engineering under consideration during the June meeting of the Engineers Joint Council held in the Engineering Societies Building, New York, N. Y., June 16, 1949.

Utilization

Utilization of engineering in the Armed Forces has been a concern of the EJC since the end of the war. In co-operation with the National Military Establishment, EJC member societies conducted a survey of members to determine how their skills were employed in the recent war. The returns showed that only 30 per cent of engineering personnel were employed at a level of technical responsibility commensurate with their training and experience (see pages 263–264, March, 1949, issue of Mechanical Engineering).

With the objective of improving use of engineering talent by the Armed Forces, the EJC authorized appointment of a committee of five representatives, one each from its member societies, to draft a statement of policy and procedures for better utilization in the future and to plan a program of action to secure acceptance of these policies.

The new committee will co-ordinate its work with the program of the Personnel Policies Board recently created by the Secretary of Defense to carry out the following tasks:

1 The study of personnel policies for both military and civilian personnel throughout the National Military Establishment, the development, where desirable, of uniform policies, and the elimination of unnecessary duplication and overlapping.

2 The placing under one authority of all interdepartmental boards, committees, and agencies which are directly concerned with civilian or military personnel policy matters within the National Military Establishment and of the function of such boards, committees, and agencies.

It is likely that an eminent engineer will be appointed to represent the engineering profession on the Board.

The program to be outlined by the EJC is expected to be useful also to the National Security Resources Board which is responsible in case of emergency for the over-all allocation of man power and for advising the President on policies to be set for the Selective Service Board. The engineering profession and the nation stand to benefit from this EJC project.

Military Classification

As one of the important phases of proper utilization, the Department of the Army recently invited EJC member societies to prepare descriptions of special skill in their branches of engineering. In response, the EJC authorized formation of a task group on military classification to be composed of two members from each member society to prepare the job descriptions requested.

Federal Civil Service

The EJC is endeavoring to establish an Engineers Advisory Committee to the U. S. Civil Service Commission to advise the Commission on such matters as qualification standards, examination and recruiting techniques, and investigations pertaining to engineering personnel. Committees of this type already serve the Commission in the fields of social and physical sciences.

In its first progress report, the EJC Committee on Engineers in Civil Service reported that each of its members was acting as a subcommittee to explore relations in Federal service of employer and employee in his own particular field of engineering. Because of the scope of its task, a number of task committees which will recruit specialists in personnel and civil-service procedures, will be established. In communities where Federal civil service is of special interest to members, the Committee suggested that local groups be organized to aid in the work.

A letter from the Reconstruction Finance Corporation, asking aid in raising standards for engineers in Federal Government, was recently received according to the report.

International Federation

In line with EJC support of international organizations of engineers, the Council is participating in the "London Conference" of western European professional engineering societies, to be held in September, 1949. This conference, composed of the presidents and secretaries of engineering societies, first convened in October, 1948, to discuss problems of common interest (see page 1032, December, 1948, issue of Mechanical Engineering). Presently represented on the conference are the principal engineering societies of Sweden, Norway, Denmark, Holland, Belgium, Switzerland, France, the three British institutions, and the AIEE, ASME, and ASCE who represent the EJC.

The Council also took part in the Pan-American Congress recently concluded in Rio de Janeiro, at which a federation of engineering societies of the Western Hemisphere was proposed.

Since the membership standards of the London Conference Societies and those participating in the Pan-American Congress are on the level of EJC and do not admit organizations with membership on the subprofessional level, EJC is in a position to act as a catalyst in bringing about an international federation of engineering societies made up in the beginning of the societies of the two groups.

When such a federation comes into being, the Council agreed to support its affiliation with the United Nations as the world-wide representative of the engineering profession.

Engineering Councils

For guidance of EJC member societies, the Council directed its Committee on Unity of the Engineering Profession to formulate policies covering scope, activities, and relationships of the various state and local engineering councils now being organized in many sections of the country to work on local projects with the work of the EJC.

Progress Report on ECPD Activities

At a meeting of the Executive Committee of the Engineers' Council for Professional Development on May 23, 1949, H. T. Heald, president, Illinois Institute of Technology, and chairman ECPD Committee on Engineering Schools, announced that 106 engineering colleges have been visited by inspection committees during the past two years. A total of 481 curriculums have been inspected, including 112 new curriculum inspections. It is anticipated that by the end of the inspection year, a large share of the previously accredited curriculums will have been reviewed and virtually all new curriculums for which inspection has been requested will have been examined.

The Committee on Engineering Schools is also studying the accreditation of graduate work in engineering. It is also attempting to develop better procedures for handling specialized engineering curriculums.

The Committee on Professional Development, headed by A. C. Monteith, Mem. ASME,

and vice-president Westinghouse Electric Corporation, is embarking upon a seven-point program, focusing attention upon improving the professional training in the postgraduation years. This program includes:

1 Comprehensive survey of postgraduate programs in engineering colleges, industry, the government, and engineering societies.

2 Study of methods of developing community-level programs aimed at improving the professional status and training of the engineer.

3 Analysis of the professional registration of engineers.

4 Encouragement of personal appraisal of the engineer in relation to his job, his community, and the engineering profession.

5 A study of orientation and training programs in industry, with a view toward disseminating information along this line which will aid both large and small companies in developing suitable programs.

6 Revision of selected bibliographies of engineering subjects.

7 Preparation of a selected reading list for young engineers.

The last two projects are nearing completion.

Questionnaire Seeks Data on Pricing Factors

A TWO-PAGE questionnaire was recently mailed to more than 60 companies cooperating in a study of pricing practices sponsored by the Distribution Committee of the Management Division of The American Society of Mechanical Engineers.

The questionnaire was drafted to provide data to establish recent trends in productivity and distribution, to demonstrate the relationship of these trends to selling prices, and to establish the role of certain physical factors encountered in distribution in determining the prices of finished products.

The year of 1939 was selected as the base year for all comparative data because it was an official year for a government census of manufacturing, and most companies would have data readily available for that year.

The questionnaire is divided into three parts. The first seeks data for the years of 1939 and 1948 on such items as number of units produced, man-hours required for production, factory prices, number of units entering distribution channels, man-hours required for distribution, investments in production facilities and marketing costs. The second seeks information on distribution channel used and distance of principal markets. The third part asks for a classification of the organization and the principal line of products for the two years.

The present study was undertaken by the ASME Management Division early in 1949 to restate the relationship between prices and productivity, and to redefine physical factors which affect cost of distribution of manufactured products.

John H. Hall, Mem. ASME, Shell Oil Company, New York, N. Y., is chairman of the ASME Management Division's Distribution Committee.

How Engineers Can Aid in Medical Research

Engineers and Doctors Meet at Cornell Medical Center

ENGINEERS are eager to contribute to the engineering problems associated with medical research, but many of them do not know what they can do to help or how to make the contacts which would provide this information, according to Luis de Florez, Mem. ASME, president, de Florez Engineering Company, Inc., New York, N. Y.

Admiral de Florez was the first speaker at an informal gathering of engineers and medical investigators in the cafeteria of the Cornell Medical Center, New York, N. Y., June 17, 1949, sponsored jointly by the faculty of the Cornell University Medical College and the Committee of Engineers Co-Operating in Medical Research of the Engineers Joint Council.

Picnic Atmosphere

A hot and humid night ripe for informality, a keg of beer, and mountains of potato chips and pretzels helped to create an ideal picnic atmosphere in which some 80 members divided equally between the engineering and medical professions, took off their coats, cussed the weather, and got down to the business of discussing each other's personal and professional problems. The purpose of the gathering was to create just such an opportunity for interprofessional comradeship.

More to focus discussion than as a pretense at formality, Dr. Eugene F. DuBois of the Cornell Medical Center, called on spokesmen of the engineering and medical professions to discuss some of the common interests of the two groups.

Referring to the work of Capt. R. D. Conrad, assistant director, Brookhaven National Laboratory, who for several years has been conducting a personal campaign to win financial and engineering support for cancer research, Admiral de Florez characterized engineers as humble men, poor in everything but technical know-how and the will to contribute their time and talent to medical investigation if they but know what is required of them and how to get started.

Need for Precision Instruments

As spokesman for the medical investigators present, Dr. C. P. Rhoads, director of the Sloan-Kettering Institute for Cancer Research, told the group that medical research was constantly increasing in complexity and depended more and more on instruments of precision. The medical profession, Dr. Rhoads said, would welcome aid from engineers in attacking the nonmedical problems of an engineering nature currently hampering medical investigations.

Co-operation and an exchange of experience can give rise to important ideas, Dr. Rhoads said.

At the suggestion of Dr. William A. Geohegan, Members AIEE, and a member of the faculty of the Cornell University Medical College, Dr. DuBois called on several medical investigators to describe some of their work and to point out where engineering assistance would be most helpful. From the discussion it was apparent that research tools and methods were among the primary needs, and that some of the problems were indeed a challenge to the engineering profession.

Medical-Research Exhibits

To acquaint engineers with the instruments, techniques, and procedures used by medical investigators, 19 exhibits in various parts of the Medical Center were open for inspection. Escorted by members of the medical group, engineers were impressed by the mass of mechanical and electrical equipment in each of the laboratories which, in most cases, were obscured by medical objective of the projects exhibited. Engineers were told that commercial instruments designed for medical investigation were generally not available, and that medical research was often held up for many months and sometimes abandoned because of failure to modify or adopt available instruments to obtain the medical data sought.

Opportunity for Engineers

If nonmedical engineering problems currently associated with medical research could be solved by engineers working in industrial laboratories, hospital space now devoted to this activity could be used more profitably for purely medical phases of research, and medical investigators would be spared the waste inherent in nonmedical effort. It was on this working level where a strong community of interest between the professions was apparent, and where engineers could make an immediate contribution by working with medical investigators in an atmosphere of friendly informality.

When the inspections were concluded, the groups returned to the cafeteria to continue discussion of common problems and experiences. Following a suggestion made earlier, engineers indicated their specialities on registration cards. These were turned over to the EJC Committee to be used for calling in engineers whose industrial experience was germane to medical projects under way.

How to Get Started

Engineers in the New York metropolitan area who want to devote time to nonmedical problems obstructing work of medical investigators and do not know how to get started, are invited to write to the EJC Committee of Engineers Co-Operating in Medical Research, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y. The Committee will pass such information on to representatives of the medical profession. Such offers will be followed by invitations to visit medical laboratories where fruitful contacts can be made.

Engineers Advise New York City on New Smoke-Control Program

NEW YORK City authorities recently sought and received the aid of the engineering profession in organizing a program of smoke abatement to solve what the *New York Times* called the "city's most vexing problem."

William H. Byrne, Mem. ASME, consulting engineer, well known for his work in smoke control, and utility appraisal work, was appointed acting director of the new Smoke Control Board created by a city ordinance which became law in February, 1949.

Mr. Bryne was one of several engineers recommended to Mayor William O'Dwyer by a conference of engineering societies aided by several local trade and civic groups interested in smoke control. This group met at the headquarters of The American Society of Mechanical Engineers over a period of several months to propose a budget, minimum enforcement organization, and a slate of qualified engineers from which city authorities could appoint administrative personnel.

Co-operating organizations were: National Association of Power Engineers, American Society of Heating and Ventilating Engineers, Real Estate Board of New York City, Commerce and Industry Association, Citizens Housing and Planning Council, American Smoke Prevention Association, Citizens Union, and the ASME.

Mr. Bryne is expected to return to his consulting practice after he has initiated the control program and after a permanent director is appointed to carry on the work.

To assure the city that politics will not be involved in the appointment of technical personnel, Mayor O'Dwyer stated that he will be guided in making appointments by the recommendations of a Selection Board composed of representatives of the ASME, NAPE, and the ASHVE.

Representing the ASME on the Board are Stephen F. Voorhees, senior partner, Voorhees, Walker, Foley and Smith; Walter S. Finley, Jr., executive vice-president, J. G. White Engineering Company; and Harry S. Rogers, president, Polytechnic Institute of Brooklyn. Other representatives are: for ASHVE, Walter L. Fleisher, president, Air and Refrigeration Corporation, and Carl F. Kayan, professor, Columbia University; for NAPE, Horace W. Wilds, building manager, New York Life Insurance Company, and Philip W. Swain, editor, *Power*, McGraw-Hill Publishing Company.

The Board has held several meetings in the Engineers' Club, New York, N. Y., and is making a study of smoke-prevention experience of the large industrial cities of the nation in its search for an engineer to head New York City's new program.

In assuming his new responsibilities, Mr. Byrne's first concern was for permanent office space for the new smoke-control unit. Mr. Byrne said he favored quarters in a high building which would aid in the "spotting" of heavy smoke and soot violations. He also asked for small spotter space in the tall buildings in Brooklyn and Queens.

Mr. Byrne predicted that New York's smoke-control program would show tangible results in about two years, and that genuinely effective control could be expected a few years later.

ISO Proposes International Boiler Code

THE Boiler Code Committee of The American Society of Mechanical Engineers, which stands vigil over safety in the boiler and pressure-vessel industry of the United States, recently accepted similar responsibility in the international field.

At the invitation of the International Standardization Organization, whose membership consists of the national standardization authorities of 27 countries, the ASME has accepted the secretariat of the ISO project on "Test Pressures for the Acceptance of Stationary Boilers and Unification of Boiler Construction Codes, ISO/TC 11."

The project was officially proposed by Howard Coonley, Assoc. ASME, and chairman of the ASME Board on Codes and Standards, at the recent meeting of the ISO Council held in Paris, France, July 5 and 6, 1949. Mr. Coonley, as chairman of the executive committee of the American Standards Association, was official spokesman for American industry at the meeting. Mr. Coonley is also president of ISO.

International standardization in the boiler and pressure-vessel field was first proposed by the Union of South Africa in 1944, but no action was taken by the ISO because American participation was uncertain.

Recent success with international standardization of screw threads by Great Britain, Canada, and the United States has stimulated interest of American industry in this field. Success of the project was assured when, in response to unofficial queries from the American Standards Association, the ASME expressed its willingness not only to participate in but to assume administrative responsibility for the project.

Seventeen countries have expressed interest in the project. They are: Belgium, Brazil, Denmark, Finland, France, Hungary, India, Italy, Mexico, The Netherlands, Norway, Palestine, Portugal, Sweden, Switzerland, U.S.A., and the U.S.S.R.

Completion of the project is expected to take several years and probably result in a continuing international authority of eminent engineers who will shoulder the task interpreting code provisions much as the ASME Boiler Code Committee does for American industry. Some of the first decisions this group will face will concern units and metric systems to be used and whether the proposed code will cover locomotive boilers as well as stationary power boilers, whether the code will concern itself with care, maintenance, and inspection procedures, and perhaps of most importance, the question of materials standards. Meetings will have to be held in this country and abroad, but it is expected that much of the work will be done by correspondence.

The ASME Boiler Construction Code which has been adopted by 32 states in this country and nine provinces of Canada, will serve as a model for the international document.

Politics and Engineers

ENGINEERS are inviting disaster if they let their natural desire for isolation from politics and economics make them indifferent to social problems, Charles Edison, president of Thomas A. Edison, Inc., former governor of New Jersey, told the 1949 graduating class of Stevens Institute of Technology. Mr. Edison was awarded the honorary degree of doctor of engineering.

"Engineers have traditionally been indifferent to the social problems created by their work," Mr. Edison said. People are quick to accept the benefits of advancements in engineering, such as improved transportation, electricity, and radio, he pointed out, but they are less willing—and now that they are predominantly urban, less able—to sustain technological or other unemployment.

Indifference of engineers to the broad problems they produce is due partly to their intense concentration on a particular piece of work, with little thought to its effect on people, and partly to their almost entirely technical training, Mr. Edison explained. They do not seem to "take kindly" to the social sciences, he said, perhaps because they get impatient with the inexactness and uncertainty of these studies.

"But in spite of the engineer's natural and understandable desire to pursue his profession in isolation from politics and economics, I am sorry to say he cannot," Mr. Edison asserted. "Either he must take a hand in the game or somebody else, somebody he may dislike and distrust, will play his hand for him."

The time when one man could invent and develop machines and processes during his spare time with small funds has all but gone, he stated. Engineering is becoming a group profession which requires large capital funds, he said, and politics and economics largely determine the availability of such funds.

For example, he pointed out that high income and inheritance taxes have made it rare today for any one individual to be wealthy enough to provide the capital for any substantial engineering job. Similarly, high corporation taxes reduce the portion of a company's funds that can be devoted to development and research.

The alternative to development of engineering in private hands is its development by the government, Mr. Edison continued. Some projects government has taken over, such as building bridges and highways, could not conveniently be turned over to private or corporate enterprise. Yet the more engineering projects are taken over by the government,

the more engineers must expect that decisions as to what engineering work is done, how, where, and by whom, will be political decisions, he said, adding that engineers who work for governments must not expect engineering decision always to be reached by a "nice balancing of scientific considerations."

"One of the most dangerous decisions you can make will be to leave politics to the politicians," Mr. Edison cautioned. "That is, leaving yourself and your profession to them. Politics will determine our ways of life and we might as well have our say and use what influence we have to make those decisions good, just, and progressive."

Meetings of Other Societies

Aug. 22–26
National Association of Power Engineers, Inc., national convention, Hotel Sherman, Chicago, Ill.

Aug. 23–26
American Institute of Electrical Engineers, Pacific general meeting, Fairmont Hotel, San Francisco, Calif.

Sept. 6–9
American Institute of Chemical Engineers, Montreal (regional) meeting, Mount Royal Hotel, Montreal, Can.

Sept. 19–23
American Chemical Society, 116th national meeting, Atlantic City, N. J.

Sept. 19–23
Illuminating Engineering Society, national technical conference, French Lick Springs Hotel, French Lick Springs, Ind.

Oct. 3–4
National Association of Corrosion Engineers, south central region, annual meeting, Adolphus Hotel, Dallas, Texas

Oct. 3–6
Association of Iron and Steel Engineers, annual convention, Hotel William Penn, Pittsburgh, Pa.

Oct. 11–14
American Standards Association, Inc., annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

Oct. 17–20
American Gas Association, annual convention, Chicago, Ill.

Oct. 17–21
American Institute of Electrical Engineers, Midwest general meeting, Netherland Plaza Hotel, Cincinnati, Ohio

(For ASME Calendar of Coming Events see page 704)

Education

Rensselaer Host at ASEE 57th Annual Meeting

Thorndike Saville Elected President

WITH Rensselaer Polytechnic Institute as host institution, the American Society for Engineering Education held its 57th annual meeting at Troy, N. Y., June 20–24, 1949, concurrently with the Engineering College Administrative Council and the Engineering College Research Council. Registration exceeded 1800 and attendance at the annual dinner on June 23, at which C. J. Freund, president ASEE, dean of engineering, University of Detroit, Detroit, Mich., Mem. ASME, presided, was upward of 700 persons.

General sessions, conferences, inspection trips, and a special program for women afforded more opportunities for intellectual refreshment, good fellowship, and entertainment than any one visitor could absorb.

At the annual dinner, the Honorable George V. Allen, Assistant Secretary of State, delivered the principal address, "Our International Obligations."

Thorndike Saville Elected President

Thorndike Saville, dean, college of engineering, New York University, was elected president ASEE. Other officers elected were: B. J. Robertson, University of Minnesota, Minneapolis, Minn., vice-president (to fill the unexpired term of Thorndike Saville); H. H. Armsby, U. S. Office of Education, Washington, D. C., vice-president; and J. S. Thompson, White Plains, N. Y., treasurer (re-elected). Arthur B. Bronwell, Northwestern University, Evanston, Ill., was reappointed secretary.

K. T. Compton receives Lamme Medal

Karl T. Compton, chairman, National Military Establishment Research and Development Board, until recently president Massachusetts Institute of Technology, and president ASEE, 1938–1939, was awarded the Lamme Medal for 1949, "for his achievements in scientific and engineering education as a teacher, research worker, administrator, and author, for his broad understanding of the relation of education to production and of the engineering college to industry; for his leadership in evaluating staff, equipment, course content in accrediting engineering curriculums; for his imaginative insight into the application of science and engineering to the defense of the nation at war, for his wise counsel to the president of the United States and those in military leadership with him."

Joseph Marin Honored

The George Westinghouse Award was given to Joseph Marin, professor of engineering mechanics at the Pennsylvania State College, and Mem. ASME, "for his effective contributions to the training of graduate and undergraduate students in the field of applied mechanics; for his important contributions, through research, to knowledge of the applications of principles of mechanics to the uses of engineering materials; for his many scientific and technical articles which have brought the results of experimental researches into reach of practicing engineers; and for his painstaking efforts to develop better teaching materials in the form of textbooks, class notes, problems, and laboratory equipment."

Future Meeting Announced

It was announced that the 58th annual meeting would be held at the University of Washington, Seattle, Wash., June 19–23, 1950.

ECRC Elects New Members

NINE engineering schools were elected members of the Engineering College Research Council of the American Society for Engineering Education at a meeting of the council held during the ASEE annual meeting at Rensselaer Polytechnic Institute, Troy, N. Y., June 20–25, 1949.

The schools are: University of California at Los Angeles, Catholic University of America, University of Arkansas, University of Denver, Montana School of Mines, Northeastern University, University of Notre Dame, Tufts College, and Wayne University. Each has qualified for membership by virtue of the extent and quality of the engineering research conducted at the institution.

New members of the council's executive committee are: Thomas L. Joseph, assistant dean, School of Mines, University of Minnesota; J. Hugh Hamilton, director, Utah Engineering Experiment Station, University of Utah; and Albert G. Conrad, head, department of electrical engineering, Yale University. Roy M. Green, dean, college of engineering, University of Nebraska, was renamed to the executive committee and will serve as a vice-chairman of the council.

* * *

S. S. STEINBERG, dean of the University of Maryland College of Engineering, was invited to attend the First Pan-American Engineering Congress held in Rio de Janeiro, Brazil, July 15–24, 1949, as a guest of honor of the congress, with expenses paid by the Brazilian Government. Dean Steinberg was official delegate of the Engineers Joint Council.

Dean Steinberg also took part in a meeting of engineers representing most of the countries of the Western Hemisphere which was held at Sao Paulo, Brazil, prior to the Rio congress.

The meeting was called to organize a Pan-American union of engineering societies.

* * *

ROBERT E. DOHERTY, Fellow ASME, will retire as president of Carnegie Institute of Technology, July 1, 1949. John C. Warner, dean of graduate studies and head of the chemistry department, has been named president-elect and will serve as vice-president of the institute until his inauguration after Dr. Doherty's retirement.

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MARIO CARL GIANNINI, professor, college of engineering, New York University, New York, N. Y., was appointed assistant dean in charge of the Day Division. Dean Thorndike Saville announced the appointment on June 27, 1949.

Engineering Literature

Screw Threads

A 34-PAGE compilation of useful information of external screw threads taken from the recently published Unified and American Screw Threads Standards has been published by the Reed Rolled Thread Die Company, Worcester, Mass. This booklet is one of several being prepared by individual companies in the machine-tool industry to encourage transition to the new standards.

The booklet is much more than an abstract of external thread information appearing in the original standard published by The American Society of Mechanical Engineers. It contains commentary on the relatively minor differences between the old and new standards. Especially helpful are some charts and tables not contained in the complete standard, which make a comparison between the threads of the new Class 2A and the old Classes 2 and 3. One chart, for example, presents graphically a comparison of allowances, limits, and pitch-diameter tolerances of normal diameters up to and including one inch. Another table designated "External Thread Designations," shows the various thread series incorporated into the Unified, and the new and old American Standards. Length of engagements for the various thread services are arranged in another table which users will find convenient.

Copies of the booklet are available from the Reed Rolled Thread Die Company, Worcester 2, Mass. Price is 75 cents.

Smoke Regulations

AS AN aid to communities considering smoke-regulation ordinance, The American Society of Mechanical Engineers recently published "Example Sections for a Smoke Regulation Ordinance." The 12-page pamphlet is made available as an information bulletin and was prepared by the Model Smoke Law Committee of the ASME Fuels Division.

The example sections are the result of more than eight years of work and reflect the thinking of many associations interested in smoke prevention. Approved by the Stoker Manufacturers Association, the sections served as the basis of recent smoke ordinance in New York, N. Y., and have already been studied and used by more than 100 other cities in making changes and adopting new smoke ordinances. They also serve as the basis for smoke-abatement recommendations of the Coal Producers Committee for Smoke Abatement and the Coal Trade Association of Indiana.

The model law recommends creation of a department of smoke regulation and advisory board of five members, three of whom are engineers. It lists the duties of this department and grants authority to the chief smoke-regulation engineer to promulgate rules and regulations. In Section 8, "smoke the appearance of which is equal to or darker than No. 2 of the Ringelmann Chart" is prohibited, except for limited periods under certain conditions. The limit for dust in gases is set at 0.85 lb per 1000 lb of gases. The model law contains 14 sections, each of which is followed by pertinent comment.

Copies are available from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. The price is 50 cents.

Conveyer Code

H. C. KELLER, Mem. ASME, chairman of the American Standards Association Sectional Committee B20, has announced that the American Standard Safety Code for Conveyers, Cableways, and Related Equipment is currently being revised. This Code, which contains provisions for the safe construction, installation, operation, and maintenance of conveyers and conveying machinery, was published in 1947 as a guide for state authorities in the formulation of state safety regulations. Two years' use of the Code has indicated the need for some revision and expansion. Comments and suggested changes should be addressed to H. C. Keller, chairman, B20, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

Materials Handling

THOSE who enjoyed the Third Annual Materials Handling Conference held in Philadelphia, Pa., Jan. 10–14, 1949, but missed the excellent technical program now have available a convenient package in the form of an 82-page proceedings containing all of the 30 papers presented covering materials-handling techniques, case histories, and equipment along with significant discussion.

The conference was sponsored by The American Society of Mechanical Engineers and the Materials Handling Institute. The technical program was arranged by the Materials Handling and Management Divisions of the ASME. The comprehensive approach to modern materials handling characterizing the sessions is suggested by the classification of the papers under the following headings: Opportunities for management, improvements in methods, case histories, co-ordinating materials handling, advances in techniques, equipment symposium, and materials handling of tomorrow.

The proceedings are available from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y., at $2 a copy.

People

CLYDE E. WILLIAMS, Mem. ASME, director of Battelle Memorial Institute, Columbus, Ohio, received the honorary degree of doctor of engineering at the recent commencement ceremonies of the Michigan College of Mining and Technology, Houghton, Mich., in recognition of significant contributions in the field of science and public service.

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FREDERIC ALAN SCHAFF, Fellow ASME, chairman of the board of Combustion Engineering-Superheater, Inc., was honored by Purdue University at the commencement exercises, June 19, 1949, with the degree of doctor of engineering. Mr. Schaff was graduated from Purdue in 1907.

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WILBER M. WILSON, professor at the University of Illinois, widely known for his work in the field of structural engineering, was named the 1949 winner of the Marston Medal by Iowa State College, Ames, Iowa.

* * *

ROY D. HALL, associated with the Lamp Division of the Westinghouse Electric Corporation, Bloomfield, N. J., for 38 years, is the fifth recipient of the medal awarded annually by Stevens Institute of Technology, Hoboken, N. J. for outstanding achievement in the field of powder metallurgy. Dr. Harvey N. Davis, president of Stevens Institute, presented the medal at a ceremony following a dinner honoring Dr. Hall. After the presentation, Dr. Hall gave the annual medal lecture. His topic was "The Use of Trace Elements in Powder Metallurgy."

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HENRY H. SNELLING, Mem. ASME, was awarded the Oliver Owen Kuhn Trophy by the Montgomery County Civic Federation at the Bethesda (Md.) Elementary School for outstanding public service to the county over the last few years. Mr. Snelling, who has been a delegate to the federation since 1936, was cited for his work on the County Safety Board. He had also served as chairman of the Committee on Public Safety.

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HUGH L. DRYDEN, Mem. ASME, director of aeronautical research for the National Advisory Committee for Aeronautics, was awarded the honorary degree of doctor of science at the ninety-fourth annual graduation exercises of the Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

ASME NEWS

Tentative Program ASME 1949 Fall Meeting Erie, Pa., Sept. 27–30, 1949

Headquarters: Hotel Lawrence

AFTER the successful Semi-Annual Meeting held this summer in San Francisco, Calif., at which members had the chance to inspect and discuss industrial development on the West Coast, The American Society of Mechanical Engineers will hold its Fall Meeting in Erie, Pa., Sept. 27–30, 1949, in one of the most diversified industrial cities of the East. Hotel Lawrence will serve as headquarters.

As guests of the Erie Section, ASME members and guests will enjoy a technical program as varied as the industrial interests of their hosts, a social program that promises to set a high mark in good fellowship, and an opportunity to inspect numerous manufacturing plants and to judge firsthand the state of the country's industrial health.

Adequate hotel accommodations have been assured for all who plan to participate in the meeting. Reservations should be made early for the best accommodations. Requests for rooms should be addressed to W. L. Hunter, chairman, Finance Committee, ASME Fall Meeting, Box 302, Erie, Pa. In addition to the headquarters hotel, accommodations have been arranged in the following hotels: Richford, Fisher, Vernon, and Village.

While the meeting will get under way officially on Wednesday, Sept. 28, registrations will begin on Tuesday, Sept. 27. For members who arrive early, two inspection trips have been arranged to outlying industrial plants, the first to Talon, Inc., Meadville, Pa., and the other to the American Locomotive Company's plant in Dunkirk, N. Y., including a free luncheon, courtesy of the American Locomotive Company, at the Shorewood Country Club on Route 5 on the outskirts of Dunkirk. In the evening an informal get-acquainted party will be held at the headquarters hotel. These premeeting events, held as they are before technical interests, business obligations, and committee responsibilities, accelerate the pace, have a charm peculiarly their own. Old friends meet, the seeds of new friendships are planted, and the pattern of the meeting is set in informality and good fellowship. These few free and unhurried hours give members an opportunity to seek out familiar faces and generally to learn who is who. Those who can arrange their schedule to include the Tuesday events at the Fall Meeting will be adequately rewarded.

The social high light of the meeting will be the banquet on Thursday, Sept. 29. U. S. Senator Edward Martin, former governor of Pennsylvania, will be the main speaker. As a major-general, Senator Martin was in command of Pennsylvania's Keystone Division when it was called into service in World War II. He trained the division for overseas service and won official commendation for his qualities of leadership. W. E. Hirt, supreme court judge of Erie, Pa., will be toastmaster.

Plant Trips

If the host Section had planned its meeting only around inspections of local industry, the Fall Meeting would have been an interesting one to all members of the ASME family, because the manufacturing companies of Erie produce so many of the mechanical devices which make the high standard of American living. Locomotives, refrigerators, Talon fasteners, engines, brass fittings, cooking utensils, and gas ranges—all stem from Erie. A large number of companies will hold open house for ASME members. All members of the ASME family will also be able to see how things are made and what American industry is doing in the way of manufacturing techniques to help keep the prices down.

The Technical Program

Twenty-one technical sessions compose the technical program at which more than 30 papers will be presented in such fields as: Management, power, heat transfer, production engineering, metals engineering, machine design, fuels, industrial instruments and regulators, aviation, gas-turbine power, materials handling, petroleum, railroad, rubber and plastics, and education.

Committee

Members of the Fall Meeting General Arrangements Committee are: G. W. Wilson, general chairman; F. D. Mosher, vice-chairman; J. L. Knight, chairman, Entertainment; B. S. Cain, chairman, Technical Events; F. D. Gowans, vice-chairman, Technical Events; Dudley Selden, chairman, Hotel; W. W. Peters, chairman, Information and Registration; G. L. Lindsay, chairman, Reception; R. W. Bronson, chairman, Plant Trips; H. W. Gouldthorpe, chairman, Publicity; W. L. Hunter, chairman, Finance; and Mrs. Dudley Selden, chairman, Women's Program.

The Tentative Program

TUESDAY, SEPTEMBER 27

10:00 a.m.

Registration

12:00 noon

Luncheon at Shorewood Country Club, courtesy of American Locomotive Company

1:00 p.m.

Inspection Trips

Talon, Incorporated, Meadville, Pa.

American Locomotive Company, Dunkirk, N. Y.

6:15 p.m.

Informal Dance

WEDNESDAY, SEPTEMBER 28

9:30 a.m.

Metals Engineering

Sonic Testing of Heavy Forgings, by R. W. Snowden, Heppenstall Company, Pittsburgh, Pa.

Craig Scott

AERIAL VIEW OF ERIE, PA., WHERE THE 1949 FALL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS WILL BE HELD, SEPT. 27–30, 1949

(Two additional papers to be announced.)

Power (I)—Fuels (I)

Fly Ash From Stokers, by E. M. Powell, design engineer, Combustion Engineering-Superheater, Inc., New York, N. Y.

Fly-Ash Erosion in Boilers, by Arthur R. Weismantle, assistant manager, and Nicholas C. Artsay, senior design engineer, steam division, Foster-Wheeler Corporation, New York, N. Y.

Fly-Ash Erosion of Boiler Surface, by W. D. Stevens, staff engineer, The Babcock & Wilcox Company, New York, N. Y.

Fly-Ash Erosion in Boilers, by L. V. Andrews, chief operating engineer, and C. F. Hawley, assistant chief mechanical engineer, Riley Stoker Corporation, Worcester, Mass.

Rubber and Plastics (I)

Strength-Variance Studies of Plastics, by W. J. Gailus, research associate, Massachusetts Institute of Technology, Cambridge, Mass.

Effect of Fuel-Immersion on Laminated Plastics, by W. A. Crouse, Margie Carickhoff, and Margaret A. Fisher, National Bureau of Standards, Washington, D. C.

Laminated Plastics Under Creep, Fatigue, and Static Loads, by W. N. Findley, research associate professor, University of Illinois, Urbana, Ill.

12:15 p.m.

Welcome Luncheon

Toastmaster: J. C. Rhoads, division engineer, Locomotive Engineering Division, General Electric Company, Erie, Pa.

Mayor's Welcome: Honorable Joseph C. Martin of Erie.

Speaker: Norman Wilson, president, Hammermill Paper Company, Erie, Pa.

2:30 p.m.

Rubber and Plastics (II)

Recent Developments in Rubber and Plastic Machinery, by Donald Chase, Farrel-Birmingham Company, Ansonia, Conn.

Automatic Tire Vulcanizing and Debagging Machine, by A. S. Michelson, The McNeil Machinery and Engineering Company, Akron, Ohio

Time as a Process Variable, by J. S. Detwiler, Taylor Instrument Companies, Rochester, N. Y.

Power (II)—Applied Mechanics

Analysis of Experimental Data Regarding Certain Design Features of Pressure Vessels, by Glen J. Schoessow, manager and chief engineer, engineering department and E. A. Brooks, The Babcock & Wilcox Company, Barberton, Ohio

Fabrication of Pressure Vessels, by O. R. Carpenter, director, Works Control Laboratory, The Babcock & Wilcox Company, Barberton, Ohio

Experimental Technique in Pressure-Vessel Testing, by L. F. Kooistra, assistant director, Materials Laboratory, research and development department and R. U. Blaser, The Babcock & Wilcox Company, Alliance, Ohio

Education

(To be announced)

SENATOR EDWARD MARTIN OF PENNSYLVANIA WHO WILL BE THE FALL MEETING BANQUET SPEAKER

Inspection Trip

General Electric Locomotive Division
General Electric Refrigeration Division

THURSDAY, SEPTEMBER 29

9:30 a.m.

Materials Handling

(To be announced)

Industrial Instruments and Regulators

Instrument Engineering—Its Growth and Promise in Process-Control Problems, by Gordon S. Brown, department of electrical engineering, servomechanisms laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

Railroad (I)

A Method of Calculating Tractive Force of Reciprocating Steam Locomotives, by John C. Wallace, design engineer, Lima-Hamilton Corporation, Lima, Ohio. (49—F-5)

Gas-Turbine Electric-Locomotive Report, by A. H. Morey, project engineer, General Electric Company, Erie, Pa.

Coal-Handling Systems for Locomotives—Past, Present, and Future, by J. J. Kane, development engineer, The Standard Stoker Company, Inc., Erie, Pa.

Management

Management a Trusteeship

Employee and Community Relations, by H. LeR. Emmet, works manager, Erie Works, General Electric Company, Erie, Pa.

Management's Responsibility to Stockholders, by F. J. Spang, president, Spang and Company, Butler, Pa.

12:15 p.m.

General Luncheon

Toastmaster: E. T. Knobloch, president, Union Iron Works and Erie Chamber of Commerce, Erie, Pa.

Remarks: F. A. Faville, president, Faville-LeVally Corporation, Chicago, Ill.

Subject: Engineers' Civic Responsibility

Speaker: K. B. McEachron, Jr., education supervisor, General Electric Company, Pittsfield, Mass.

2:30 p.m.

Railroad (II)

Railroad Mechanical Testing, by E. D. Hall, engineer of tests and chief chemist, Erie Railroad Company, Meadville, Pa.

Under-Car Engine-Driven Power Plant for Railroad Passenger Cars, by D. R. MacLeod, commercial engineer, General Electric Company, Erie, Pa. (49—F-7)

Gas Turbine Power (I)

Gas Turbines for Vehicles, by Frank L. Schwartz, professor of mechanical engineering, University of Michigan, Ann Arbor, Mich.

Small-Output Gas Turbines, by Anthony T. Balint, associate professor, school of engineering, University of Buffalo, Buffalo, N. Y. (49—F-1)

Heat Transfer

Combination of Heat Sources and Sinks by the Method of Superposition, by Frank A. Bridgers, instructor, School of Mechanical Engineering, Purdue University, Lafayette, Ind.

Temperature Charts for Heating With Internal Heat Sources, by Victor Paschkis, technical director, heat and mass flow analyzer laboratory, and M. P. Heisler, Columbia University, New York, N. Y.

Economic Thickness of Cylindrical Insulation, by Victor Paschkis, technical director, heat and mass flow analyzer laboratory, Columbia University, New York, N. Y.

Production Engineering

Handling Time Versus Machining Time, by Edward L. Murray, engineer, Warner and Swasey Company, Cleveland, Ohio

Mechanization of Refrigeration-Unit Muffle-Box Assembly, by C. A. Rystogi, superin-

G. W. WILSON, GENERAL CHAIRMAN FOR THE ASME FALL MEETING

tendent of refrigerator-unit manufacturing department, General Electric Company, Erie, Pa.

Inspection Trip

2:30 p.m.

American Sterilizer Company

7:00 p.m.

Banquet

Toastmaster: Honorable Wm. E. Hirt, Superior Court Judge, Erie, Pa.
President's Remarks: James M. Todd, president, ASME.
Speaker: Honorable Edward Martin, senator, Pennsylvania

FRIDAY, SEPTEMBER 30

9:30 a.m.

Machine Design (I)

Development of a Special Four-Spindle Boring Machine for Finishing Traction-Motor Magnet Frames, by G. A. Baltus, supervisor, manufacturing development section, General Electric Company, Erie, Pa., and D. H. Garmoe, sales engineer, W. F. & John Barnes Company, Rockford, Ill. (49—F-3)

Heavy-Duty Bearings With Intermittent Oscillatory Motion, by R. R. Bush, development engineer, switchgear division, General Electric Company, Philadelphia, Pa. (49—F-2)

9:30 a.m.

Fuels (II)

Cleaning Coal, by Thomas F. Downing, Jr., Philadelphia Electric Company, Philadelphia, Pa.

Coal-Handling Systems for Central Plant, by W. A. Kaercher.

Aviation (I)

The Characteristics of Elastomers With Respect to Vibration in Aircraft, by W. A. Keetch, senior product engineer, Lord Manufacturing Company, Erie, Pa. (49—F-9)

Aircraft Vibration Mounting Problems, by G. L. Wannall, group engineer, The Glenn L. Martin Company, Baltimore, Md.

Gas Turbine Power (II)

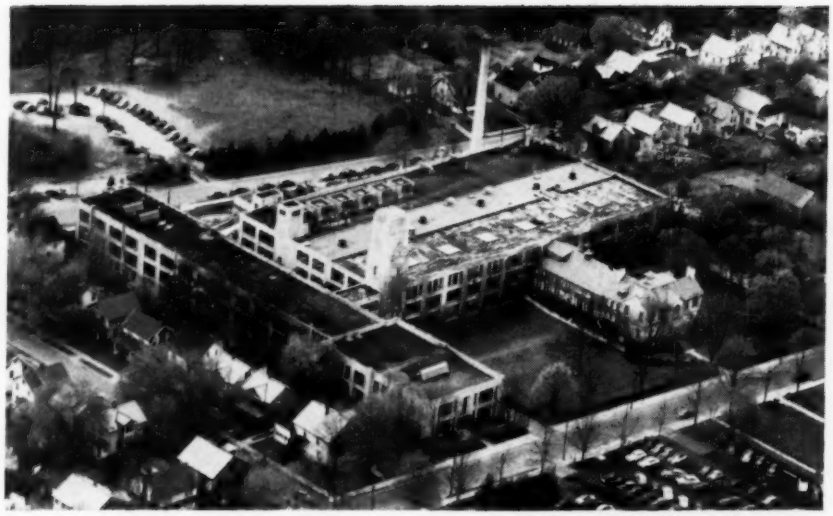
The Exhaust-Heated Gas-Turbine Cycle, by Donald L. Mordell, associate professor of mechanical engineering and director of gas-dynamics laboratory, McGill University, Montreal, Quebec, Canada. (49—F-6)

Properties and Characteristics of Fuel Oils for Industrial Gas-Turbine Usage, by D. P. Heath, research associate, and E. Albat, chemical engineer, Socony-Vacuum Oil Company, Inc., Paulsboro, N. J.

12:15 p.m.

General Luncheon

Toastmaster: M. M. Boring, staff assistant to vice-president, charge engineering, General Electric Company, Schenectady, N. Y.
Subject: The Interrelations of Technical Education and Industry
Speaker: T. Keith Glennan, president, Case Institute of Technology, Cleveland, Ohio



Davis and McKinney Company

PLANT NO. 5 OF TALON, INC., ONE OF THE PLANTS TO BE VISITED DURING THE ASME FALL MEETING

2:30 p.m.

Aviation (II)

Temperature Effects on the Axial Vibration of Turbine Disks, by J. W. Simpson, vibration engineer, Fredric Flater, Inc., North Tonawanda, N. Y.

Aero-Hydro Glider Pickup Winch, by Alexander Cowie, lecturer in mechanical engineering, Illinois Institute of Technology, Chicago, Il. (49—F-10)

Petroleum—Fuels (III)

Practical Considerations in Industrial Oil Firing, by H. E. Schwiebert, product engineer, gas and fuel-oil department, Socony-Vacuum Oil Company, New York, N. Y.

Oil-Fired Settings for Small Boilers, by Kalman Steiner, fuel engineer, C. Hoffberger Company, Baltimore, Md.

Machine Design (II)

Some Engineering Problems Associated With Metals and Elevated-Temperature Service, by Fred G. Sefing, research metallurgist, International Nickel Company, Inc., New York, N. Y.

Engineering Aspects of the Surgical Operating Table, by R. L. Jewell, chief engineer, American Sterilizer Company, Erie, Pa. (49—F-4)

Inspection Trip

2:30 p.m.

Erie Forge and Steel Company

Women's Program

Special entertainment, a tea, sightseeing tours, inspection trips, luncheons and dinners make up the attractive program arranged by the women of the ASME Erie Section for the Fall Meeting. Beginning with the Get-Acquainted Party, Tuesday evening, the program includes a special luncheon at the General Electric Community Center, to be followed by a tour of the Refrigerator Division on Wednesday, and other delightful events.

IIRD Contributes to 1949 Instruments Conference

THE Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers is participating in the fourth Instruments Conference and Exposition to be held at the Municipal Auditorium, St. Louis, Mo., Sept. 12–16, 1949. The conference is sponsored jointly by the Instruments Society of America, the Instruments and Measurements Committee of the American Institute of Electrical Engineers, American Institute of Physics, Scientific Apparatus Makers Association, National Telemetering Forum, and the ASME.

The ASME contribution to the program will be three technical sessions and a luncheon.

MONDAY, SEPT. 12

2:30 p.m.

Theoretical Considerations on the Optimum Adjustment of Regulators, by P. Hazebroek and B. L. van der Waerden, N. V. de Bataafsche Petroleum Maatschappij of Holland.

The Optimum Adjustment of Regulators, by the same authors.

(Both papers will be read by N. B. Nichols, Taylor Instrument Company, Rochester, N. Y.)

TUESDAY, SEPT. 13

12:30 p.m.

Luncheon

2:30 p.m.

The International Temperature Scale of 1948, by Harold F. Stimson, chief, temperature-measurement section, National Bureau of Standards, Washington, D. C.

The Attenuation of Oscillatory Pressures in Instrument Lines, by Arthur S. Iberall, physicist, mechanical-instruments section, National Bureau of Standards, Washington, D. C.

WEDNESDAY, SEPT. 14

2:30 p.m.

Control Systems for Distillation Towers, by C. Pyle, engineering research laboratory, E. I. du Pont de Nemours and Company, Wilmington, Del.

Practical Approximations for Summarizing Square Function Measurements of Two Flows, by D. T. Gunderson.

Technical sessions sponsored by other participating organizations will cover production processes, testing, inspection, and instrumentation analysis of scientific instruments.

The social high light of the conference will be a three-hour trip on the Mississippi passenger steamer, *S. S. Admiral*. The vessel has an air-conditioned ballroom and other facilities for recreation.

The instruments exposition will consist of more than 150 exhibits of instrument manufacturers displaying products of all branches of the industry.

Six Papers Scheduled for ASME Wood Industries Conference

THE Wood Industries Division of The American Society of Mechanical Engineers will hold its 1949 annual conference at Hotel Jamestown, Jamestown, N. Y., Sept. 27, 1949.

Technical sessions are planned for the morning and evening. Following a luncheon at which G. E. Helgram, treasurer, Kling Factories, Mayville, N. Y., will preside, and at which Earle O. Hultquist, president, Jamestown Royal Upholstery Corporation, will speak on "Sales and Engineering," the afternoon will be given over to inspection trips. Social events are planned to complete the program.

Members planning to attend the conference should make reservations early. When doing so please mention the ASME Wood Industries Conference and indicate time and days of arrival and departure. Some 50 rooms have been reserved for ASME members at the headquarters hotel.

Since the conference precedes the ASME 1949 Fall Meeting at Hotel Lawrence, Erie, Pa., Sept. 27–30, 1949, members will have an opportunity to participate in the Fall Meeting program.

The program follows:

TUESDAY, SEPTEMBER 27

8:00 a.m.

Registration

9:00 a.m.

Session

Fundamentals of Adhesion, by G. M. Kline, chief organic plastics section, and F. W. Reinhart, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C.

Recent Developments in Resinous Wood Adhesives, by Henry Grinsfelder, laboratory department head, resinous-products division, Rohm and Haas Company, Inc., Philadelphia, Pa.

Glue Spreaders—A Study in Design, by T. D. Perry, engineer in woodwork, Moorestown, N. J.

High-Frequency Assembly-Gluing, by W. H. Hickok, director of application engineering, thermex division, Girdler Corporation, Louisville, Ky.

12:00 noon

Luncheon

Presiding: G. E. Helgram, treasurer, Kling Factories, Mayville, N. Y.

Speaker: Earle O. Hultquist, president, Jamestown Royal Upholstery Corporation, Jamestown, N. Y.

Subject: Sales and Engineering

2:00 p.m.

Inspection Trips

1 Crawford Furniture Manufacturing Corporation and Jamestown-Sterling Corporation

2 Jamestown Veneer and Plywood Corporation

3 Kling Factories, Mayville, N. Y.

6:30 p.m.

Group Dinners

8:00 p.m.

Session II

Selections and Application of Cutter Heads for Wood, by Kenneth Duff, Henry Disston & Sons, Inc., Seattle, Wash.

Two Slants on Postwar Wood Finishing

Current Practice, by Paul S. Kennedy, vice-president, finishes division, Interchemical Corporation, Newark, N. J.

Suggested Method for Predicting Check Resistance of Lacquer Films, by W. T. Smith, supervisor, physical testing laboratory, finishes division, Interchemical Corporation, Newark, N. J.

Engineering Frontiersmen Named at ASME Semi-Annual Meeting

THE 1949 Semi-Annual Meeting of The American Society of Mechanical Engineers held at San Francisco, Calif., June 27–July 1, 1949, was one of the many events planned by national organizations to honor the centenary of the great Western trek which helped to establish California as a State of the Union. The meeting, attended by more than 700 engineering and business leaders from all sections of the country, called attention to the tremendous industrial growth of the nation and particularly to the rugged pioneer spirit which converted, within the time span of 100 years, a sparsely settled territory into one abounding in cities, large industries, and gigantic public works.

James M. Todd, president ASME, speaking at the Semi-Annual banquet, had this progress in mind when he chose "Mechanical-Engineering Frontiersmen" as his subject. After reviewing engineering frontiers of 1949 he named the engineers who were currently living on the border and beyond the frontiers of mechanical-engineering knowledge. Foremost among these he placed Lillian M. Gilbreth, Fellow ASME, whose studies in the principles of motion and whose techniques are one of the great contributions to engineering which has assured American hegemony in the industrial arts. President Todd told the meeting that engineering leadership extends beyond the fields of engineering into other areas of industrial and world problems, areas in which engineers speak and think as citizens of a leading nation.

Stating that he wished to make honorable mention of a few other leaders even at the "risk of omitting some," Mr. Todd named:

D. Robert Yarnall, past-president of ASME, and recipient of the Hoover Medal in 1941 for "a lifetime of civic service and his devotion to improving world understanding through his leadership in the American Friends Committee." Mr. Yarnall is president of the Yarnall-Waring Company of Philadelphia, Pa.

William L. Batt, president of SKF Industries, Inc., of Philadelphia, past-president of ASME, former president of the International Committee on Scientific Management, wartime American chairman of the Joint Combined Resources and Production Board. Mr. Batt actively supported the program that led to international standardization of screw threads.

Howard Coonley, president of the American Standards Association and of the International Standards Organization, and a "powerful influence in better world understanding through technical standards." Mr. Coonley is a member of ASME.

H. B. Maynard, president of the National Management Council and a member of the International Committee on Scientific Management, "an apostle for the dissemination of American know-how abroad."

Robert M. Gates, ASME past-president and representative of Engineers Joint Council on the U. S. National Commission for UNESCO, "working diligently to secure better understanding by other fields of science of the possibilities inherent in engineering for the well-being of the world."

E. G. Bailey, past-president ASME, and a recent Clayton Lecturer before The Institution of Mechanical Engineers in London, Manchester, England, and Glasgow, Scotland, "who did useful service as chairman of the National Engineers Committee in recruiting leaders for the Economic Cooperation Administration and who, as an individual, is making his wide experience available to his colleagues in other nations."

Harold V. Coes, past-president ASME, who in May went to Paris to take charge of the distribution of industrial equipment to Marshall plan countries.

A full account of the meeting will appear in the September issue.

GENERAL ARRANGEMENTS COMMITTEE OF THE 1949 SEMI-ANNUAL MEETING HELD IN SAN FRANCISCO, CALIF., JUNE 27–JULY 1, 1949

(*Left to right:* Harry J. Smith, Transportation Committee; John B. Link, Housing Committee; L. F. Thompson, convention counselor; Ernest Hartford, executive assistant secretary; Roger D. McCoy, Publicity Committee; Walter Kassebohm, general chairman; Claude D. Purves-Smith, Entertainment; J. Calvin Brown, regional vice-president; Alf Hansen, Women's Program; Thaxter Andruss, Plant Trips Committee; and Robert F. Schlitzkus, chairman, Finance Committee.)

ASME Nominations for 1950

JAMES DALTON CUNNINGHAM, Fellow ASME, president of Republic Flow Meters Company, Chicago, Ill., was nominated by the 1949 Nominating Committee on June 28, 1949, for the office of President for 1950 of The American Society of Mechanical Engineers, during the Semi-Annual Meeting of the Society held in San Francisco, Calif. Mr. Cunningham is a pioneer in the field of the development of industrial instruments and control devices and has been the president of his company since 1911.

Vice-Presidents

The other members of the Society whose names were placed in nomination for national office were: FRANK MCCLELLAN GUNBY, renominated for Vice-President, ASME Region I, served in this office from 1947 to 1949 and has been active in the affairs of both the national committees and the Boston Section. Mr. Gunby has for many years been an associate and director of Charles T. Main, Inc., Boston, Mass. His work in general industrial engineering, designing plants, and making reports and appraisals of various kinds of industrial and power situations has taken him to India, Argentina, Canada, and Mexico.

JOHN CLIFFORD REED, nominated Vice-President, ASME Region III, is professor of mechanical engineering and head of the mechanical-engineering department of Bucknell University, Lewisburg, Pa., since 1942. Professor Reed has taught mechanical engineering and allied subjects at the University of Illinois; School of Mines, University of Colorado; and Bucknell University. He has served as consultant on power and engineering projects, contributed much to the literature in the field of hydraulics, refrigeration, and fluid mechanics. He has been engaged in the activities of the local Sections and was honorary chairman of the student branches both at the School of Mines, Colorado University, and at Bucknell University.

ALBERT C. PASINI, nominated Vice-President, ASME Region V, is superintendent of the production department of The Detroit Edison Company, Detroit, Mich., where he has been employed since 1923. Mr. Pasini has served as secretary-treasurer and as chairman of the Detroit Section and is currently chairman of the National Membership Development Committee.

SAMUEL HERMAN GRAF, Fellow ASME, director of the engineering experimental station, Oregon State College, Corvallis, Ore., nominated Vice-President, ASME Region VII, has done extensive work as a consultant and is president of the state board of engineering examiners. He has taught at Oregon State College since 1908. His national offices in the Society were Manager, 1943–1945, and Director at Large, 1945–1946.

Directors at Large

THOMAS EDWARD PURCELL, Fellow ASME, general superintendent, power stations, Duquesne Light Company, Pittsburgh, Pa., was nominated Director at Large for four years. Twice he has served as Vice-President of the Society. Mr. Purcell has written many technical articles on matters pertaining to the steam and electric-utility fields and has produced several inventions in those fields.

BENJAMIN PARKER GRAVES, Fellow ASME, director of design, Brown and Sharpe Manufacturing Company, Providence, R. I., was nominated Director at Large for four years. Mr. Graves holds many patents and is the contributor of an impressive list of papers which have been published in technical periodicals.

Complete biographical data and photographs will be published in the September, 1949, issue of MECHANICAL ENGINEERING.

L. M. Gilbreth to Address ASME Annual Meeting

THE 1949 Annual Meeting of The American Society of Mechanical Engineers to be held at the Hotel Statler, New York, N. Y., November 27 to December 2, promises to match in size and quality the ASME Annual Meetings of 1947 and 1948.

Lillian M. Gilbreth has been invited to give a talk on the subject related to "The Share or Role of Women in Design." Other speakers are being lined up for various events.

The theme of this meeting is "The Engineers' Contribution to a Peaceful World." Some idea of the variety of the 1949 program may be had from the following Divisions and Committees who are planning 79 technical sessions: American Rocket Society, Applied Mechanics, Aviation, Boiler Feedwater Studies, Effect of Temperature on the Properties of Metals, Fluid Meters, Fuels, Furnace Performance Factors, Gas-Turbine Power, Heat Transfer, High-Temperature Steam Generators, Hydraulic, Industrial Instruments and Regulators, Lubrication, Machine Design, Management, Materials Handling, Metals Engineering, Oil and Gas Power, Petroleum, Power, Process Industries, Production Engineering, Properties of Gases, Railroad, Rubber and Plastics, Safety, Textile, Vessels Under External Pressure, and Wood Industries.

Erie Section Holds Joint Meeting With AIEE

INSPECTION of the first gas-turbine locomotive was the purpose of an all-day joint meeting of the Erie Sections of the American Institute of Electrical Engineers and The American Society of Mechanical Engineers, held at the Erie Works, General Electric Company, Erie, Pa., June 24, 1949.

The program, enjoyed by 200 ASME and AIEE members and guests, consisted of four technical papers, a tour of the Erie Works, and a ride on the new Alco-GE locomotive. The technical papers were presented in two sessions: During the morning session, A. H. Morey, Mem. ASME, gave an over-all account of the design of the new locomotive. He was followed by Allan Howard, Mem. ASME, who told of the preliminary testing of the gas-turbine power plant. The afternoon session was devoted to the rotating electric equipment and to controls of the locomotive.

According to the authors, work on the locomotive began in 1945 and first tests on the rails were held in November, 1948. For an account of the unit, see pages 591–594, July, 1949, issue of MECHANICAL ENGINEERING.

ASME Calendar

of Coming Events

Sept. 12–16, 1949
ASME Industrial Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
(*Final date for submitting papers was May 1, 1949*)

Sept. 27
ASME Wood Industries Division Conference, Jamestown, N. Y.
(*Final date for submitting papers was May 1, 1949*)

Sept. 27–30
ASME Fall Meeting, Erie, Pa.
(*Final date for submitting papers was May 1, 1949*)

Oct. 2–5
ASME Petroleum Division Conference, Oklahoma Biltmore Hotel, Oklahoma City, Okla.
(*Final date for submitting papers was June 1, 1949*)

Oct. 26–27
ASME Fuels Division Conference, French Lick Springs Hotel, French Lick Springs, Ind.
(*Final date for submitting papers was June 1, 1949*)

Nov. 27–Dec. 2
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(*Final date for submitting papers was Aug. 1, 1949*)

April 10–14, 1950
ASME Spring Meeting, Hotel Statler, Washington, D. C.
(*Final date for submitting papers—Dec. 1, 1949*)

June 19–23
ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.
(*Final date for submitting papers—Feb. 1, 1950*)

Nov. 26–Dec. 1
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(*Final date for submitting papers—Aug. 1, 1950*)
(*For Meetings of Other Societies see pages 697*)

Cleveland Engineers Advise Students

BECAUSE of the "mentor plan" of the Cleveland Section of The American Society of Mechanical Engineers, engineering students in the Cleveland metropolitan area had an opportunity this spring to talk to engineers with long experience in the industry and branch of engineering they were planning to enter after graduation.

The plan was proposed for the twofold purpose of giving older members of the profession a chance to participate in professional guidance, and to demonstrate to graduating engineers that the engineering profession was conscious of their needs and was willing to help them.

Here is how the plan worked. Some 400 questionnaires were mailed to members of the Cleveland Section asking each to indicate his field of specialization. A similar questionnaire was sent to graduating engineers asking for their field of interest. With this data on the supply and demand for information, the Membership Development Committee under chairmanship of Edgar H. Cummings, American Monorail Company, Cleveland, Ohio, matched the demand with the supply and arranged for contacts.

About 110 students from Case Institute of Technology and Fenn College returned the "interest" cards, and 100 ASME members returned the "experience" cards. Many satisfying contacts were arranged, and the consensus was that the plan was worth while and should be continued and improved next year.

Publications Committee Reviewing Experience With Publications Plan

Results of Survey Announced

DURING the month of June the Publications Committee of The American Society of Mechanical Engineers asked 500 members who have not subscribed to either Transactions or *Journal of Applied Mechanics*, why they had not done so.

The members were selected at random and asked three questions: (1) Whether these subscription publications were meeting their professional needs; (2) whether the preprints service ever could be an adequate substitute for the two publications; and (3) what were their reasons for not subscribing to these journals.

The questionnaire is one of the steps taken by the Committee in its intensive study of Society publications service which has been in effect since January, 1948, on which the Committee promised to issue a report to the membership. In preparation for such a report the Committee discovered that the number of member subscribers to Transactions and *Journal of Applied Mechanics* was less than they had anticipated. Hence it was decided that what was required was a study of present-day needs and reading habits of the members.

The current plan was approved by an 8 to 1 vote of the membership in the fall of 1947. Rising costs of publication and other Society services, desire to end waste circulation caused by general free distribution, and the need for an adequate preprint service were some of the reasons for changing Society publication services following the recent war.

What disturbed the Committee was the revelation that only three per cent of the membership subscribed to Transactions or the *Journal of Applied Mechanics*, the publications through which the Society makes its permanent contributions to the knowledge of mechanical engineering.

Realizing that speculation on causes could be endless, the Committee authorized a survey of 500 nonsubscribing members to find out from individual members why they had not subscribed, and incidentally, to ask their opinions on how useful these publications were in their work.

On June 1 questionnaires listing the following questions were mailed: (1) Are the papers published in Transactions and *Journal of Applied Mechanics* meeting your technical needs? (2) If Transactions and the *Journal* should be discontinued would preprints of the papers—without discussion—and the abstracts now in MECHANICAL ENGINEERING be adequate for the profession? And (3) why have you not subscribed? Oversight? Use library copies? Cost too much? Purchase preprints? Other reasons?

When the returns began coming in, it was apparent that members were eager to co-operate with the Committee. More than 44 per cent of those interrogated returned the questionnaire. These not only answered the questions but three out of every four contributed valuable comment. A large number submitted thoughtful letters discussing the place of publications in the life of the Society, and how these were used by practicing engineers in many industries on various levels of responsibility.

Analysis of Returns

The general tone of the returns suggested that a 3 per cent member subscription to the Society's specialized publication was not unusual and that even if the price of subscriptions were lowered not more than 5 per

Metropolitan Section Fall Review Courses

THE Metropolitan Sections of the ASME and the AIEE announce the fall program of Review Courses designed to prepare engineers for New York and New Jersey professional engineer's license examinations.

The following courses will be given: Engineering Economics and Practice, Structural Planning and Design, Mechanical Engineering, Electrical Engineering and Applications, Basic Engineering Sciences and others.

Courses commence Sept. 8, 1949.

For folder write to The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

cent member subscription should be expected. Many members said that they do not need Transactions in their work because only a few papers are published in their immediate field of interest. When such papers were called to their attention by the abstracts in MECHANICAL ENGINEERING, they bought preprints. A large block of members composed mainly of those in design, education, and research, indicated that Transactions and the *Journal* were essential working tools and that preprints without discussion would not be adequate. The majority in this group used library copies. While they would prefer to have personal copies, a large number did not subscribe because the price was too high. The preprint service provided them with personal file copies of papers in which they were especially interested.

From the wealth of comment received, some tentative conclusions suggested themselves. The first of these was that the publications plan now in effect was basically sound. Some major improvements could be made, however, without disturbing its general identity.

The Society could entertain no thought of discontinuing either Transactions or the *Journal* because these publications constituted a primary contribution to engineering literature, and as such were a major Society responsibility to the engineering profession.

MECHANICAL ENGINEERING should be enlarged and its editorial policy directed to provide broader general service to the engineering profession.

The preprint scheme as now administered, was weak in some details. Changes could be made to simplify procedure by which members order and pay for preprints.

These working data have already been called to the attention of the Board on Technology which is responsible for suggesting technical policy for the Society. At a recent meeting of the Publications Committee it was felt that material would soon be available for a full report to the members before the 1949 Annual Meeting. In the meantime, members are invited to write to the Committee regarding how they feel about Society publications. Comments will be helpful and greatly appreciated. These should be addressed to George A. Stetson, editor, ASME.

Genevieve S. Wood, ASME Staff Member, Dies

GENEVIEVE SCOLLARD WOOD, member of the headquarters staff of The American Society of Mechanical Engineers since 1921, died on June 18, 1949, after a short illness. Affectionately known as "Woodsie" to hundreds of members of the ASME committees, Mrs. Wood for years was the mainstay on the staff in matters relating to Professional Divisions work. Her versatility and willingness to accept responsibility won her hosts of friends on the committees with whom she worked. She shouldered a heavy burden of work during the war years when she met the needs of not only the Textile, Oil and Gas Power, and Wood Industries Divisions but of other program-making agencies.

Born in St. Louis, Mo., June 26, 1890, she came to the staff after a short career in musical comedy where she was cast in ingénue parts. Mrs. Wood was an accomplished pianist and devoted her leisure hours to painting in oil. Many a retiring chairman found a routine presentation of his certificate enlivened by some bit of poetry from her pen.

Mrs. Wood is survived by a daughter and two grandchildren to whom she was devoted. Colorful, spontaneous, generous of her time and means, she will be long remembered by those who had the good fortune to know her.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Atlanta, June 10. Dinner meeting at East Lake Country Club. Election of officers. Attendance: 75 members and their wives.

Central Indiana, May 27. Speaker: J. M. Todd, president, ASME. Subject: The Engineer's Contribution. Attendance: 90.

Rock River Valley, June 2. Speaker: R. B. Terry. Subject: Intangible Industrial Property. Attendance: 35.

ASME Sections

Coming Meetings

Southern California: Aug. 3. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Pumps—Installation, Maintenance, and Repairs and Replacement Schedules. Speaker: P. Brown.

Aug. 10. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Piping Materials. Speaker: L. Hall.

Aug. 24. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Design and Selection of Components for Hydraulic Operating and Control Systems. Speaker: V. L. Maleev.

Aug. 31. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Engineering Specifications. Speaker: A. Hunter.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

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EFFICIENCY POWER-PLANT ENGINEER, BSME, plus operating certificates. Studying for master's degree in industrial engineering. Experience in testing equipment, water treatment, preparing operating reports, instruments maintenance. 23. Single. New York–New Jersey area. Me-465.

MECHANICAL ENGINEER, BSME, eleven years' diversified experience in rubber, chemical, and high-speed machinery. Outstanding record of completely rebuilding outmoded plants. Capable of organizing staffs with high morale. Desires permanent position anywhere. Me-466.

AERONAUTICAL ENGINEER, 29, married, BSME, four years aircraft-design drafting; eighteen months flight-test instrumentation; two years machine shop; Army aircraft maintenance. Desires development work in aeronautical or related field. Northeastern area. Me-467.

MECHANICAL ENGINEER, 29, seven years' varied experience, with majority in truck-crane carrier design, layout, specifications, and drawings. Particularly experienced in weldments. Northern New Jersey area; not essential if opportunity is good. Me-468.

JUNIOR MECHANICAL ENGINEER, 25, BMC Cooper Union, recent graduate, TBP Single. Prefers internal-combustion field, but will take any position which will provide experience and a future. Me-469.

CHIEF DRAFTSMAN OR STANDARDS ENGINEER, fifteen years' experience. Has sound engi-

[1] All men listed hold some form of ASME membership.

neering background and versatile knowledge of manufacturing methods. Can co-ordinate drafting activities to meet requirements and direct them for economical effective operation. Can streamline operations for coming competition fight. Me-470.

MECHANICAL ENGINEER, 27, master's degree; three years' experience. Tau Beta Pi. Desires position in power or prime movers. Eager to learn. East Coast. Me-471.

MECHANICAL ENGINEER, 28, BME, June 1949. Mature and conscientious, desires a position with a future; experience in airplane mechanics (three years), flight engineer (361 hours), office clerk (three years). Me-472.

DESIGN ENGINEER, 35, BSME. Twelve years' design experience in special machinery, packaging, sales. Latter years in responsible charge. Aggressive, creative, objective thinker, good manager. Prefers position as chief or assistant. Me-473.

COST ENGINEER, 30, married, BME, plus two years business courses. Desires position as industrial or production engineer. Twelve years of varied experience in inspection, production, all phases of accounting, particularly cost accounting. Me-474.

RECENT GRADUATE, 23, BS degree in industrial engineering, Wayne University, Detroit, Mich. Interested in methods or production-control work. Have some experience writing office procedures. Analyzing and charting office-form flow. Anywhere in the United States. Me-475.

JUNIOR MECHANICAL ENGINEER, 28, BS degree, Tau Beta Pi. Experience covering general manufacturing, machine shop, power plants, design, testing, and writing. Can meet people. Available immediately. East or Midwest. Me-476.

MECHANICAL ENGINEER, 48. Diversified experience in administration of maintenance, plant layout, new design of utilities, rayon, rubber, and chemical plants. Economic studies, estimates, and construction supervision. Me-477.

MECHANICAL ENGINEER, 33, married, registered in California, BSME, AB economics, seven years' experience, principally development heating and ventilating equipment; patent work. Desires permanent position with manufacturing concern in development or production. Will consider teaching. California, but will relocate. Me-478-496-D-39.

PLANT MANAGER, SUPERINTENDENT, OR MANUFACTURING ENGINEER. Twenty-five years' experience in woodworking and mechanical and electrical manufacturing. Can make substantial contribution toward production of quality products at competitive prices. Me-479.

INDUSTRIAL MANAGEMENT ENGINEER, twelve years' professional work variety of manufacturing plants. Thoroughly experienced in reducing costs through scientific management. 34; honor degree; professional engineer. Desires permanent connection with growing concern. Me-480.

MECHANICAL ENGINEER, 27, married, graduate 1943. PE experienced design, installation mechanical equipment. Thorough knowledge slurry and water-pump applications. Desires assistant plant-engineer or administrative-engineer position. Middle Atlantic. Me-481.

MECHANICAL ENGINEER, 30, Pennsylvania registration. Steel-plant maintenance, construction, operation. Naval aircraft maintenance, overhaul. Plant and production engineering, product engineering administration, mechanical, structural design. Desires sales or engineering in small company. Me-482.

MECHANICAL ENGINEER, 34, M.I.T. Graduate, PE, desires position where a thorough analytical and mathematical ability in engineering, plus a practical background, is a distinct advantage. Eight years of comprehensive experience in stress analysis, design, development, and field work on special machinery and heavy equipment. Me-483.

MECHANICAL ENGINEER, with five years' industrial experience in design, manufacturing, sales production. Interested in assisting plant engineer or superintendent. Capable of assuming responsibilities. Ambitious, energetic, hard worker. East, but willing to relocate. Me-484.

POSITIONS AVAILABLE

MECHANICAL DRAFTSMAN, experienced, for heating, plumbing, electrical, and air-conditioning work. Write, giving full information as to education, experience, etc. Virginia. Y-2539.

INDUSTRIAL ENGINEERING, mechanical or industrial graduate, with experience in time and motion study, job-analysis, work simplifications, and must have had several years' experience in the textile industry. Will be required to organize work simplification to supervisory staff, and develop a comprehensive work-production program. Must be qualified to assist in labor negotiations involving work loads. Up to $10,000 depending on ability. Maryland. Y-2540.

DESIGN ENGINEER, 26–40, graduate, with at least a BS in mechanical engineering, preferably with five years' experience in the design of parts of molded bakelite, die castings, powdered metal, pressed metal, etc., as well as some experience in factory work and an appreciation and understanding of the use of machine tools. Will work with electrical-development engineers and must be able to understand and interpret their findings into mechanical designs. Must be able to follow through some of the designs when they reach the production stage. Position requires the application of known mechanical movements to, and the development of, new mechanisms for office-dictation equipment. Opportunity for advancement. $5000. Northern New Jersey. Y-2544.

ASSISTANT DEVELOPMENT ENGINEER, 30–45, preferably mechanical graduate, with five to ten years' experience on instruments, computers, small mechanisms, etc. Some design. $6000. Lower New York State. Y-2548.

MECHANICAL DESIGNER with at least five years' electronic-instrument experience, to design test equipment for geophysical instruments. $5000–$6000. New York, N. Y. Y-2550.

MECHANICAL ENGINEER with at least five years' design, development, and production-engineering experience with precision equipment, to design mechanical components of professional sound-recording and reproducing equipment using disks or tapes. Must have good experience on small gears and elimination of vibrations. $8000–$10,000. New York metropolitan area. Y-2572.

CHIEF ENGINEER, 35–50, mechanical graduate, preferably with ten to fifteen years' experience with company manufacturing power-transmission equipment, pulleys, motors, etc. $10,000–$15,000. Indiana. Y-2575-C-D.

MECHANICAL ENGINEER, with five to ten years' experience in public-utility power plants. Work will consist of supervisory help in the efficient operation of steam-generating stations. Illinois, with traveling to various generating stations within the state. Transportation paid. Y-2595-C.

ASSISTANT DIRECTOR OF ENGINEERING, 35–45, mechanical or civil degree, with knowledge of food processes, plant maintenance. Must have twelve years' experience. Will co-ordinate specialized design work on machines and equipment; designate types and quality of materials to be used in engineering projects; originate and suggest methods and method improvement. Keep records of work being performed and jobs to be done—drawing and specification files. Will contact contractors, suppliers, and engineering firms. Must be able to supervise engineers. $7000–$8500. Minnesota. Y-2602-C.

DESIGNERS, DRAFTSMEN, AND DEVELOPMENT ENGINEERS, mechanical, with two to twenty years' experience in rock, coal, and ore crushers and washers, screens, hammer mills and belt conveyers, board, shop, and field work; problems pertaining to engineering and application of mining equipment on breakers and tipples used in mines, gravel and stone quarries, and ore pits. Salaries open. Midwest. R-5691.

CHIEF ENGINEER, thoroughly familiar with combustion-engineering applications of gas-burning equipment, temperature ranges 300 F to 1400 F, knowledge of fan performance and operation, information on large variety of installations. Will engineer and design installations of gas-burning equipment to industrial processes. $6000. Illinois. R-5715. Rewritten.

CHIEF ENGINEER, about 45, mechanical graduate, with extensive experience on tool and die design, preparation, and administration. Will be concerned with light, non-ferrous stampings for a jewelry manufacturer. Up to $12,000. Midwest. R-5731.

TEACHING PERSONNEL. (*a*) Assistant or associate professor; (*b*) Instructor or assistant professor. Must be graduate mechanical engineers, qualified to teach thermodynamics, heat-power engineering, internal-combustion engines, mechanical-engineering laboratory. Salaries open. Southwest. R-5740.

DRAFTSMEN, about 40, mechanical-engineering background, extensive and varied experience. Familiar with all phases of construction, mechanical engineering, knowledge of general construction problems. About $5200. Illinois. R-5741.

INSTRUCTOR, mechanical graduate, capable of teaching production control, materials

(*ASME News continued on page 708*)

A COMPLETE SYSTEM...

FOR INSTANT, ACCURATE CHECK ON LIQUID OR BOILER WATER LEVELS THROUGHOUT THE PLANT

Yarway Remote Liquid Level Indicator with Control Unit attached.

Now you can have constant check-up on water levels wherever —and whenever—you want.

The Yarway Liquid Level Indicator, equipped with Yarway Control Unit and auxiliary electric signalling devices, provides this check at two or more locations anywhere in the plant.

The Yarway Indicator is always accurate because it is operated by the liquid itself. Indicating mechanism is never under pressure. There are no stuffing boxes. Complete separation of indicating and actuating parts is achieved by permanent magnet transmission.

The Automatic Control Unit is attached directly to the Indicator and operates the remote signal alarms (light or horn) at any remote locations.

The Control Unit may also be used as a control for mechanical equipment such as motor-operated valves, pumps, etc.

FOR COMPLETE DESCRIPTION AND SPECIFICATIONS OF YARWAY REMOTE LIQUID LEVEL INDICATORS, WRITE FOR BULLETIN WG-1822.

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.

Visit the Fourth National Instrument Exhibit, Municipal Auditorium. St. Louis, Mo. September 12-16, 1949. See our display, Booth 207.

Yarway Remote Hi-Lo-Alarm Signal Horns.

Three Yarway Remote Hi-Lo-Alarm Signal Lights, showing low level, normal operation and high level. Each unit shows all levels.

YARWAY REMOTE LIQUID LEVEL INDICATOR

handling, plant layouts, personnel, etc. Salary open. Michigan. R-5745.

PLANT ENGINEER, mechanical-engineering background, some construction, refrigeration, heating and ventilating, packaging and equipment-layout experience for a dairy-products company. About $4800. Wisconsin. R-5746.

SALES ENGINEER, mechanical graduate or equivalent, 28–40; experienced in sale of air equipment, knowledge of fans, dust collectors, heating and ventilating, etc. Should be technically qualified to discuss industrial uses particularly in food and chemical industries. Will operate the Chicago office for a well-established manufacturing company. $6000–$8000. Illinois. R-5764.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Aug. 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALTIERE, FRED J., Youngstown, Ohio
ANDERSON, CHARLES MILLER, Lansdale, Pa.
ANTILL, C. B., JR., Brownsville, Texas
BARES, WILLIAM G., JR., Monrovia, Calif.
BERES, JOHN C., Jackson, Mich.
BIDSTRUP, LAWRENCE O., Boston, Mass.
BLUTH, LUDWIG SALOMON, Hollywood, Calif.
BLYMER, FRANK, Clarendon Hills, Pa.
BOOKE, KENNETH E., St. Louis, Mo.
BOYER, R. L., Mt. Vernon, Ohio
BOYLE, ROBERT E., Hammond, Ind.
BRITTAIN, RICHARD J., JR., Murray Hill, N. J.
BROWN, LEWIS, N. Hollywood, Calif.
BYLER, WELLAND LEROY, North Wales, Pa.
CAMPBELL, LLOYD R., Brooklyn, N. Y.
CASTELLI, F., Milan, Italy
COLE, FRED H., Culver City, Calif.
CURRAN, HUGH, Bakersfield, Calif.
DANCIU, CHARLES O., Trona, Calif.
DEJON, E. W., Bellaire, Texas
EDMONSON, GLENN V., Ann Arbor, Mich.
EMERSON, BRIAN, Merrick, N. Y.
EWART, J. NORTON, Kenmore, N. Y.
FITZSIMMONS, WM. J., Ridley Park, Pa.
FORSLUND, EDWARD E., Glendale, Calif.
GAUDREAU, ARMAND THEOPHANE, Philadelphia, Pa.
GEE, LOUIS S., Abilene, Texas
GULRAJANI, NAVAL TIRITHDAS, New Delhi, India
HAMILTON, JAMES A., Mamaroneck, N. Y.
HEGENER, WILBERT G., Evanston, Ill.
HEIM, S. F., Bayonne, N. J.
HELFENSTEIN, HUGO, New York, N. Y.
HELLER, FREDERICK C., Philadelphia, Pa.
HEWITT, WARREN H., San Francisco, Calif.
HOLCOMB, CALVIN W., Columbus, Mo.
HYDE, E. B., 3RD, Flushing, N. Y.
JAMES, R. S., Carnegie, Melbourne, Australia
JANAKI, RAM R. G., Coimbatore, S. India
JOHNSON, MEDER, Everett, Wash.
JORDAN, RICHARD W., Nutley, N. J.
KEYES, FREDERICK G., Cambridge, Mass.
KHALIL, KAZI ABDUL, Peshawar, Pakistan
KIELY, J. R., Palos Verdes Estates, Calif.
KLOEHN, BERNARD A., Milwaukee, Wis.
KNIGHT, DOUGLAS G., Poughkeepsie, N. Y.
KUHRTS, GEORGE JACOB, JR., Los Angeles, Calif.
KURK, ELMER F., Louisville, Ky.
LEICHTMAN, EDWIN S., Falls Church, Va.
LOFGREN, DONALD A., Buffalo, N. Y.
LOPEZ, RICHARD A., Brooklyn, N. Y.
LOVERING, E. W., Seymour, Conn.
MANILDI, JOSEPH FRANK, Pasadena, Calif.
MARCELLUS, B. V., San Francisco, Calif.
MARCUS, JOSEPH, Brooklyn, N. Y.
MCCAMMACK, S. E., Washington, Ind.
MCNABB, S. D., Toronto, Ont., Can.
MCNULTA, JOHN JOSEPH, Neshanic, N. J.
MOORE, JOHN ROBERT, Santa Monica, Calif.
MYKLESTAD, N. O., Urbana, Ill.
NELSON, JAMES F., Memphis, Tenn.
NEUWIRTH, LESLIE, Irvington, N. J.
NEWELL, M. A., Peoria, Ill.
NOLDE, GEORGE V., Berkeley, Calif.
ORLANDO, JOHN, Youngstown, Ohio
OSORIO, ALFREDO DO AMARAL, Rio de Janeiro, Brazil
OSTERTAG, JOHN L. L., Rosemont, Pa.
PAISS, HAROLD, Philadelphia, Pa.
PARKER, WILLIAM O., JR., Cliffside, N. C.
PERRONE, CHRISTOPHER L., Brooklyn, N. Y.
PETERSON, N. TRUMOND, Inglewood, Calif.
PONSFORD, E. M., State College, N. Mex.
PHILP, FLOYD, Long Beach, Calif.
PRINGLE, ORAN ALLAN, Columbia, Mo.
PORSE, LAURIDS, Los Angeles, Calif.
RAGSDALE, WILLIAM HUDSON, Pontiac, Mich.
RIBAL, JORGE GUTIERREZ, Havana, Cuba
ROGER, AUDRO WOOD, Raleigh, N. C.
ROUNTHWAITE, GEORGE HAMPTON, Lualualei, Oahu, T. H.
RUBNER, RICHARD R., Chicago, Ill.
SANDERS, JESSE CLARENCE, Long Beach, Calif.
SCHULTZ, FRANK LESTER, Chicago, Ill.
SHAFER, JOSEPH RICHARDSON, Los Angeles, Calif.
SHANNAHAN, J. H., Los Angeles, Calif.
SMITH, HARRY B., Statesboro, Ga.
SMITH, HARRY HOXIE, San Francisco, Calif.
SPIER, WILLIAM B., Birmingham, Ala.
STANTON, BURR, St. Louis, Mo.
STOMBERG, ANDREW WORTHINGTON, Alliance, Ohio
SUMMERSBY, JOHN J., Summit, N. J.
SYROVY, GEORGE K., Umatilla, Ore.
THAL-LARSEN, HERMAN, Berkeley, Calif.
TIEMANN, WILLIS FREDERICK, Springfield, Ohio
TRADER, WILLIAM JOHN, Chicago, Ill.
TURTON, CHARLES F., Phoenix, Ariz.
TYREE, WILLIAM DENNIS, Nashville, Tenn.
VALEHRACH, EMIL M., Bronx, N. Y.
WATERS, CHARLES E., Evanston, Ill.
WAY, GORDON LINDSAY, San Francisco, Calif.
WEISMAN, CHAUNCEY, Niagara Falls, N. Y.
WEISNER, RUDOLPH R., Longueuil, Que., Can.
WELLS, ROBERT LEE, Grand Rapids, Mich.
WILLS, H. A., Melbourne, Australia
YEAKLE, RONALD N., Charlotte, N. C.

CHANGE IN GRADING

Transfers to Member or Associate

BARRETT, LEROY, Arcadia, Calif.
BORDT, FRED J., JR., Averill Park, N. Y.
BUNKER, ROBERT P., Asheboro, N. C.
DELORENZO, ANGELO PAUL, Brooklyn, N. Y.
ECHEVERRIA, R. JAMES, San Mateo, Calif.
GAGNE, ANTOINE, F., JR., Bridgeport, Conn.
LACY, JAMES WORTHAM, Dallas, Texas
MONTGOMERY, CHARLES D., Havre de Grace, Md.
MONTGOMERY, WALTER L., Knoxville, Tenn.
SYROVY, GERALD H., Richland, Wash.
TRUMPLER, WILLIAM E., JR., Media, Pa.
VICHICH, FRED L., Endicott, N. Y.

Transfers from Student Member to Junior 400

Obituaries

Dickerson Gregory Baker (1870–1949)

DICKERSON G. BAKER, retired research engineer of the American Thread Co. and an authority on filament winding, died on May 28, 1949, at his home in Holyoke, Mass. Born, Palmyra, N. C., July 12, 1870. Education, public schools. Mem. ASME, 1905. Survived by his wife, Mrs. Ellen Stronach Baker, a son, Martin H., a daughter, Mrs. J. J. White and a sister, Mrs. E. F. Martin.

Frank Breckenridge Bell (1876–1949)

FRANK BRECKENRIDGE BELL, founder and chairman of the board of the Edgewater Steel Co., Pittsburgh, Pa., and chief of the Pittsburgh District Ordnance during most of World War II, died on May 6, 1949, at the West Penn Hospital after an illness of several weeks. Born, Mercer, Pa., Sept. 24, 1876. Parents, John W. and Hester Martin (Davitt) Bell. Education, ME, Lehigh University, 1897. Married Mary Ewing Stranahan, 1904. Honorary DE Lehigh University, 1944. He received the Award of Merit from the President of the U.S.; he won the Frank A. Scott Gold Medal for distinguished Ordnance services. Mem. ASME, 1918; Fellow ASME, 1948. Served on the General Committee of the Management Division, and on the Metals Engineering Handbook Board. Survived by his wife, two sons, Davitt Stranahan and James Alexander Bell, all of Pittsburgh, Pa.; a daughter, Mrs. Joseph L. Higginbotham, Dallas, Texas; and eleven grandchildren.

Leon Beskin (1911–1948)

LEON BESKIN, assistant chief for design and research, Bureau of Aeronautics, Navy Department, died in July, 1948. Born, Lenin-

(*ASME News continued on page 710*)

CENTRIFUGAL BLOWERS...

PRODUCTS OF *R-C dual-ability*

This new bulletin gives you the latest information on Roots-Connersville Centrifugal Blowers and Exhausters. It includes characteristic performance curves; details and illustrations of R-C units, both single-stage and multi-stage; data on regulation and control; and other pertinent facts to help you specify blowers or exhausters. Ask for Bulletin 120-B-14.

It is a companion piece to the two bulletins described at the right. Together, these make up the "R-C *dual-ability team*"—the only source from which you can obtain both Centrifugal and Rotary Positive Blowers and Exhausters.

You should have all three in your data files and they will be sent on your request.

ROOTS-CONNERSVILLE BLOWER CORPORATION
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ROOTS-CONNERSVILLE

BLOWER BUILDERS R-C SINCE 1854

BLOWERS • EXHAUSTERS • BOOSTERS • LIQUID AND VACUUM PUMPS • METERS • INERT GAS GENERATORS

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THESE BULLETINS WILL HELP YOU

Rotary Positive Blowers—details on design and construction of R-C Rotary Positive Blowers; characteristic performance curves and other helpful data. Ask for Bulletin 22-23-B-13.

Rotary Positive Gas Pumps—essential data for the selection of gas pumps, including sizes, capacities, performance curves and factual proof of long-time, successful operation. Ask for Bulletin 32-33-B-13.

grad, Russia, Dec. 22, 1911. Parents, Salomon Besohkine and Mathilde Beskin. Education, Paris, France, Lycee (Baccalaureat Scholar, 1927); Ingenieur des Arts et Manufactures, Ecole Centrale des Arts et Manufactures, 1932; LLB, Paris University, 1934; Paris University, Sciences, Higher Mathematics, Theoretical Mechanics, degree in 1937. Contributed greatly to the field of technical literature both here and abroad. Mem. ASME, 1947.

Francis Marvin Bond (1880–1949)

FRANCIS M. BOND, assistant director of the Industrial Bureau of the Baltimore Association of Commerce for the last twenty-two years, died of a heart attack on June 2, 1949, while being driven to work. Born, Blacksburg, Va., July 12, 1880. Parents, Rev. Dr. B. W. Bond, Methodist bishop, and Mrs. Bond. Education, AB, Randolph Macon College, 1902; SB, Massachusetts Institute of Technology, 1908. Jun. ASME, 1909; Mem. ASME, 1915. Survived by his wife, Mrs. Katharine Hooper Bond, a daughter, Mrs. Lyttleton Ballard, a son, Francis H. Bond, a student at Johns Hopkins University; and two brothers, Dr. B. W. Bond, Jr., and William L. Bond.

Davis Brown (1860–1949)

DAVIS BROWN, consulting engineer, died at his home in Montebello, Calif., on May 20, 1949. Born, Portland, Ind., Aug. 18, 1860. Parents, Aaron and Mary (Robertson) Brown. Education, teacher's certificate, Liber College. Married Mary E. Denney, 1889; children, Elmer L., A. Raymond, E. Ruth, and Darthea M. Married 2nd, Maybelle Young. Mem. ASME, 1916. Survived by his wife, Maybelle Y. Brown, a son, A. R. Brown, Toledo, Ohio, two daughters, E. Ruth Oppenlander, Bucyrus, Ohio, and Darthea M. Patterson, Los Angeles, Calif.; and two grandchildren.

Joseph Raymond Carlton (1880–1949)

JOSEPH R. CARLTON, former mechanical division chief, Maplewood Testing Laboratory, who retired in 1947 after more than forty-one years with the company, died May 17, 1949, after a long illness. Born, Bordentown, N. J., May 31, 1880. Education, BSEE, Notre Dame University, 1901. Mem. ASME, 1918. Served as vice-chairman, 1929–1949, and as secretary, 1929–1947, of the Research Committee on Fluid Meters. Survived by his wife, Mrs. Rose G. Carlton.

Samuel Mills Dean (1891–1949)

SAMUEL M. DEAN, chief engineer of the system of The Detroit Edison Co., and vice-president of the Board of Street Railway Commissioners of Detroit, Mich., died in Women's Hospital, Detroit, Mich., May 31, 1949, of a heart ailment. Born, Traverse City, Mich., July 15, 1891. Parents, Walter W. and Emily T. (Burroughs) Dean. Education, BSEE, Michigan State College, 1914. Married Frances E. Hurd, 1915. Honorary DE, Michigan State College, 1948. Mr. Dean was president of The Engineering Society of Detroit and past-chairman of its Civic Affairs Committee. "Detroit Engineers' Public Activities," published in MECHANICAL ENGINEERING, March, 1947, pages 193–196, describes some of the projects undertaken by this group. Mem. ASME, 1947. Survived by his wife and two daughters, Mrs. John E. Swisher, Jr., Ann Arbor, Mich., and Mrs. Warren B. Clark, Palm Beach, Fla.

Elmer George Elliott (1869–1949)

E. G. ELLIOTT, retired mechanical designer, died in Phoenix, Ariz., April 1, 1949. Born, Detroit, Mich., Jan. 11, 1869. Parents, Charles Henry and Elizabeth Martha Elliott. Education, public schools, Cook's Institute, New York, N. Y. Married Edith M. Martin, 1903, who died Sept. 21, 1947. They had no children. Mem. ASME, 1907.

John Gillespie Galt (1919–1949)

JOHN G. GALT, plant manager of the Keystone Trappe Rock Co., Glen Moore, Pa., died in 1949. Born, Lancaster, Pa., June 9, 1919. Education, Haverford School, 1938; BSME, Duke University, 1942. Jun. Mem. ASME, 1942.

Harry Arthur Hopf (1882–1949)

HARRY A. HOPF, management-engineer and president of Hopf Institute of Management Inc., died of heart disease at the Ossining (N. Y.) Hospital on June 3, 1949, after a prolonged illness. His home was Windrose Farm, Ossining, where he also conducted his business. Born, London, England, April 3, 1882. Parents, Charles and Franziska (Grote) Hopf; came to the United States, 1898; naturalized, 1903. Education, Ober-Realschule, Kassel, Germany; BSC, MCS, MBA, all from New York University, 1906, 1914, and 1922, respectively; postgraduate student, Columbia University, 1927–1928. Married Flora Paine, 1908; children, Elliott Arthur and Gordon Allen. Married 2nd, Rita Hilborn, 1926. He is the author of numerous monographs and articles dealing with various phases of management. Honorary degrees: MS, Bryant College, Providence, R. I., 1937; DE, Rensselaer Polytechnic Institute, 1942. In 1938 he received the gold medal of the International Committee of Scientific Management; in 1947 he received the Taylor Key Award of the Society for the Advancement of Management; and in 1948 he was made a knight of the Royal Order of the North Star by King Gustav of Sweden. Assoc. ASME, 1918; Mem. ASME, 1930. Survived by his wife, who was his business partner, and two sons, Elliott A., Massillon, Ohio, and Gordon A., Bronxville, N. Y.; and four grandchildren.

Nicholas Kulik (1915–1949)

NICHOLAS KULIK, associate professor of mechanical engineering, New York University, was drowned on May 29, 1949, while fishing in an outboard motor on Peconic Bay. His home was at Carle Place, L. I., N. Y. Born Rochester, N. Y., Feb. 23, 1915. Education, ME, Cornell University, 1938; MME, Cornell University, 1940; PhD, Purdue University, 1945. Jun. ASME, 1941. Survived by wife, Mrs. Constance Baum Kulik; two daughters, Constance and Claire; and his parents, Mr. and Mrs. Michael Kulik, Rochester, N. Y.

Lester Andrew Magraw (1883–1949)

LESTER ANDREW MAGRAW, president, Central Illinois Public Service Co., Springfield, Ill., died March 25, 1949. Born, Springfield, Mass., May 7, 1883. Parents, Dennis Andrew and Nora (Quinn) Magraw. Education, BS, Worcester (Mass.) Polytechnic Institute, 1905. Married Sarah De Saussure Davis, 1912. Mem. ASME, 1920.

Charles Ralph Martin (1886–1949)

CHARLES R. MARTIN, a sales engineer in the hydraulic department of Allis-Chalmers Manufacturing Co., Milwaukee, Wis., died May 9, 1949, in Milwaukee. Born, Alto, Ind., Dec. 13, 1886. Parents, George C. and Margaret Hester Martin. Education, BSME, Purdue University, 1908. Married Addie L. Mielenz, 1917; Mem. ASME, 1921.

Carle Jewett Merrill (1883–1949)

CARLE JEWETT MERRILL, treasurer and general manager, C. J. Merrill, Inc., Portland, Me., died at his home in Portland, Me., on May 6, 1949. Born, Falmouth, Me., Nov. 2, 1883. Parents, Fred Augustus and Lucretia (Patrick) Merrill. Education, BS, Tufts College, 1906. Married Cora A. Taylor, 1912; Mem. ASME, 1916.

Paul Josef Paffen (1876–1949)

PAUL J. PAFFEN, consulting industrial engineer, died in May, 1949. Born, Bleialf, Germany, Dec. 24, 1876. Parents, John J. and Anna Kate (Zimmerman) Paffen. Education, ME, Mining and Mechanical Engineering College (Bochum, Germany), 1896. Naturalized citizen of U. S., 1910. Married Anna Heissler. Mem. ASME, 1916.

Carl Theodore Schreiber (1882–1949)

CARL T. SCHREIBER, research engineer, Dri-Steam Products, Inc., New York, N. Y., died on May 22, 1949, at New Hyde Park, N. Y., where he resided. Born, Brooklyn, N. Y., April 3, 1882. Parents, Adolph and Dorothy (Weygandt) Schreiber. Education, ME, Columbia University, 1904. Mem. ASME, 1931.

Henry Wing Sumner (1870–1949)

HENRY WING SUMNER, retired engineer, died in Seattle, Wash., April 5, 1949. Born, Collinsville, Ill., Sept. 2, 1870. Parents, Augustus and Harriet A. (Brobston) Sumner. Education, attended Oberlin College, 1883–1890; received training in engineering at Cornell University. Married Maria Neely McVay, 1899, who died 1928. Jun. ASME, 1900; Mem. ASME, 1912.

LeRoy Charles Van Gorden (1895–1949)

LEROY C. VAN GORDEN, chief draftsman, machine designer, Kimble Glass Co., Vineland, N. J., died at his home in Vineland of a cerebral hemorrhage on May 25, 1949. Born, Goshen, N. Y., Dec. 21, 1895. Education, ICS, 1923. Mem. ASME, 1938. Survived by three sisters, Frances E. Van Gorden, Ethel Spicer, and Hazel Richardson.

Aldred Kennedy Warren (1866–1948)

ALDRED K. WARREN, retired manufacturing engineer, International General Electric Co., died Nov. 20, 1948. Born, Cranmore, Somersetshire, England, April 4, 1866. Parents, Rev. Edward Walpole and Agnes Sarah (Kennedy) Warren. Education, Marlborough College, Wiltshire, England, 1878–1883; King's College, London, England, 1883–1885. Married Louise Lockwood, 1891 (died 1941); children, three sons, Williston L., Aldred K., Jr., Blanchard D., and a daughter, Mrs. Janet W. Chatman. Naturalized citizen of U. S., 1917. Mem. ASME, 1920.

Y. F. Wei (1887–1949?)

The Society was recently notified that Prof. Y. F. Wei, director, technology department, Ministry of Communications, Chungking, China, has died. Born, Chekiang, China, 1887. Education, ME, Cornell University, 1912. Mem. ASME, 1945.